MAR 19 1928

Engineering News-Record

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March 15, 1928

Sewer Lining Practices with Vitrified Clay Plates

Comparative Designs for High Dam on Mokelumne Project, California

Constructing a Large-Section Highway Tunnel North Carolina

Staff Report of the Annual Meeting American Railway Engineering Association

Revetments on the Mississippi—DeBerard's Eighth Article

Mississippi Revetment Work—
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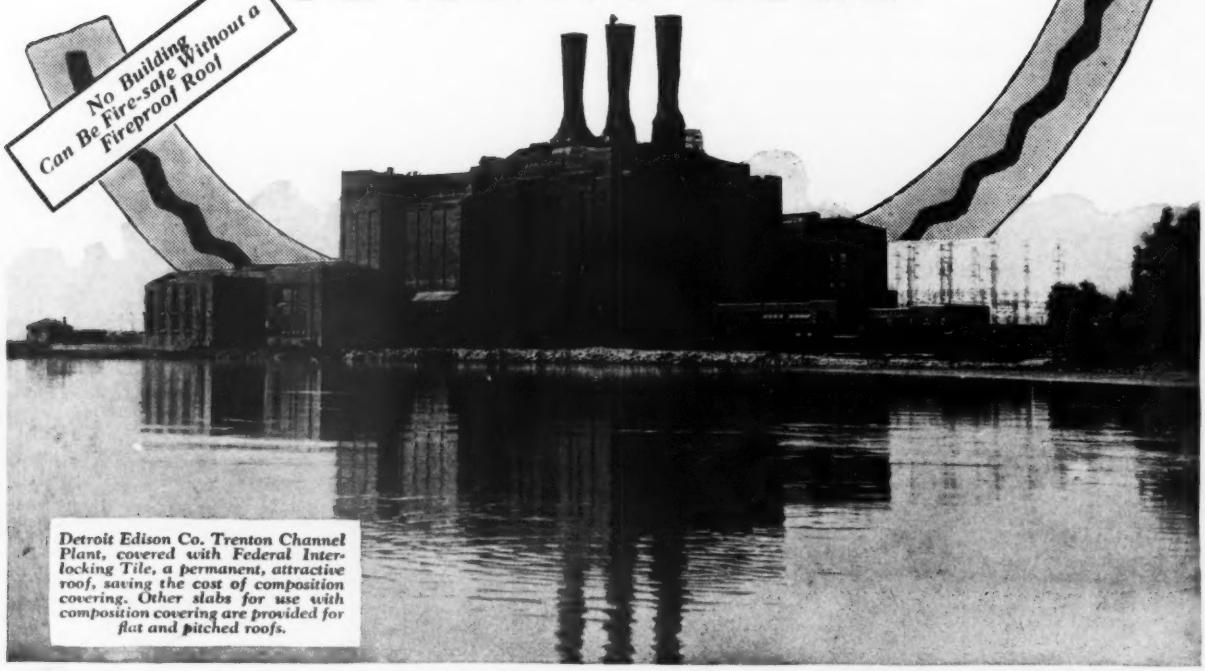

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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Continuing Construction

FULLY in accord with forecasts, the pace of construction activity continues undiminished, keeping up with that of the past two years. Our current statistics show a volume of construction slightly ahead of that of 1927. At the same time the outlook is equally satisfactory, as is made evident by the reports on projects and planning on the way to the contract stage. If some other industrial fields have been at reduced momentum in the past few months, the basic activities of building and engineering construction show not the slightest tendency of similar slowing. This fact is further proof, if any were needed, that construction is the resultant of more fundamental factors than those local and seasonal influences—or perhaps changes of mode or habit—that determine the degree of activity in other fields of work. Moreover, it is founded not only upon private and corporate requirements but upon the public works needed by cities and states in ever greater amount as community problems grow. Both business and human interests contribute to the activities of construction engineering. Thus the present record of construction rate is a clear index of the basic excellence of the country's economic state. It presages a year of maintained production.

Discussions of Unemployment

NEWSPAPER and political discussions have given a surprising prominence to unemployment in recent weeks. It has been strongly asserted that many workers are idle, that there is a serious unemployment problem, that the large cities have enough men out of work to create a charity problem. And it has been claimed just as strongly on the other side that the labor situation is normal, within the range of the usual fluctuations. What are the facts? In the large centers of population there evidently has been a concentration of drifters, and local shutdowns in some of the seasonal trades have put men out of work temporarily. Such local phenomena tend to bulk large in press dispatches and legislative debates. A different picture is revealed by a canvass made by our own representatives, summarized on p. 461 of this issue. This canvass covers the Eastern half of the country in quite representative manner. It shows that slightly more men are out of work than at this time last year, but that the difference is not great. Taking the picture as a whole, industrial and employment conditions are substantially the same for the two years. These reports relate largely to employment in the building trades, but they include also a fair proportion of data from the manufacturing industries. Again, conditions in manufacturing are gaged by records of electric power consumed in 3,000 plants, distributed all over the country, from which regular reports are received; and these show a gain of 6 per cent over the first two months of 1927—a definite reflection of greater activity and employment. Plainly, greater power consumption in manufacturing is not compatible with stoppages and idleness. Thus the results of our canvass give no support to the unemployment sensation. They indicate a sound condition throughout the region covered.

Successful Enterprise

COMPLETION of the difficult cofferdam foundations for the west piers of the Hudson River suspension bridge last week marks the accomplishment of a bold undertaking. A pioneer effort, it extends the scope of open foundation work, and will doubtless serve as precedent for much future construction in water. A few words will suggest the difficulty of the problem. The location of the piers was in open water, with bed rock sloping and shelving down from 45 to more than 70 feet below river level. The stepped and jagged surface of the rock was covered by some five or ten feet of boulders and rock débris, over which was clay and river-bottom silt. On this footing two piers about 100 feet square had to be built. The task was of such difficulty that contractors were invited to bid on their own methods of construction, either open or pneumatic. Because of this same difficulty, no doubt, the bid prices ranged over a remarkably wide spread—from one and a quarter million to nearly three million dollars. The low bid was for steel sheet-pile cofferdam construction, with single wall on the inshore end and double wall on the rest of the periphery. It involved dependence on steel sheeting fully 85 feet long; under similar conditions nothing like this had been done before. There were predictions aplenty that the undertaking would meet trouble, that the method was not suitable to the conditions, that it involved excessive hazard, and what not. But its successful execution now proves that the engineers who devised it had planned wisely as well as courageously. Their enterprise merits all the rewards of success.

Power-Shovel Studies

A STUDY of power-shovel operation in highway grading has been undertaken by the engineers of the Bureau of Public Roads and is being reported in the bureau monthly *Public Roads*. Since the early nineties, when A. E. Herman prepared his notable series of articles on steam shovels and steam-shovel work for *Engineering News*, no corresponding study by an independent investigator has been made of this outstanding device for moving earth and rock. What a change in the tool and its use the passing 35 years have recorded! When Herman wrote, the power shovel was a steam shovel and it was primarily a railway-building tool. Today one of its greatest uses is in road building. Then gas-engine and electric power shovels had not been contemplated. All the crop of full-circle shovels has grown up since

1893. The crawler traction is new. The mechanism and the materials of the shovel are largely different. Design and workmanship have been improved. The power shovel has been extended to a multitude of uses which a generation ago were not considered practicable for a steam shovel. But the fundamental principle of the old steam shovel which Otis invented remains in the modern power shovel virtually unchanged. And so if we look over the old analysis by Herman of the operating cycles of steam shovels and of servicing them with transportation, it is found that the fundamentals remain the same. It is time that they were studied again and power-shovel efficiencies appraised in the light of modern excellences of excavator mobility and flexibility and of providing means of handling excavated material.

Efficiency in Hydro Plants

COMPETITION between water power and steam power has greatly increased in recent years, having been accentuated by higher efficiencies in steam plants and lower fuel oil prices. Where periods of drought are frequent, where long transmission lines are required and in general wherever the initial investments for hydro developments are high, comparisons of present-day costs of water and steam power tend more and more to favor the latter. Under the urge of these conditions, ways and means to develop greater economies in the design of hydro-electric plants are being diligently sought. Very little increase can be expected in the efficiencies of the hydraulic units themselves, but there is room for much improvement in the efficiencies of intake works and in the handling of water generally between point of storage and prime mover. A saving of 1 per cent in efficiency is quite as valuable when gained by a simple change in headgate design as when paid for in the form of a bonus to the turbine manufacturer.

Radburn: A Garden City

IN EARLIER days now and then a monarch, and in later times an industrial concern, created a new city overnight as it were. Far more rarely such attempts have been made by what the world delights to call idealists or visionaries. The latest ventures in this field have been given the alluring name garden cities. Letchworth, England, built a few years ago by Garden Cities, Limited, was the pioneer. Nothing quite like it has yet been built in America, but land has been bought and plans are being made for a garden city near Paterson, N. J., which bids fair to surpass anything in this field yet accomplished. Radburn, the name given to this projected city with an area of a thousand acres and a population of 25,000, will combine homes, gardens and industries. A unique feature of the layout of Radburn, as stated in our news section for Feb. 16, is the setting of houses in parked areas through which footways extend to schools, playgrounds and community centers generally, with the rears of the houses and all the garages facing on service streets set at right angles to the main traffic streets. The detailed working out of the plan of Radburn will be awaited with great interest. It promises to be a distinctive contribution to city planning, not merely in its garden city features but also as pointing the way to decentralization of population and industry in this age of overgrown and almost intolerably congested cities.

Improved General Contracting

THE orderliness that characterizes in a notable way our modern construction operations is the result of co-ordination to a superlative degree. This arrangement of all things in order, time and place, and the general contractor's service as guarantor of cost and expert in fabrication, is the reason for his existence. In general he is justifying himself by his works. This, however, does not prevent assault on his position and he is finding it necessary to make sorties to protect it. Unfortunately their objects seem to have been a call for reinforcements rather than an effort to improve his own strategy and tactics. The situation merits consideration.

In building construction, for example, the contractors of the several trades are widely urging the use of separate contracts—a direct contract with each trade, instead of a general contract covering the work of all the trades. Again, the engineers and architects are saying that the general contractor is becoming merely a broker in subcontracts and is not rising to the opportunities of his work as an expert consultant upon whom they can lean when occasion arises. These are serious assaults, because there is justification back of them.

Quite commonly the business and ethical treatment of the subcontractor by the general contractor comes very close to pure exploitation for profit. Substantially all the exactions and arbitrary practices of which the engineer is accused by the general contractor are being exercised by the latter himself in dealing with subcontractors. The campaign by the construction trades for separate contracts is the natural reaction. It can be made ineffective by a little fair dealing.

Fundamentally the contracting trades are in closer harmony of understanding with the general contractor than with the professional agent of the owner, and would prefer to work under the contractor. He has only to reach out with a policy of fair dealing in order to obtain this allegiance. It can be done; there are contractors who have done it and whose strength with engineers and architects and in their business comes in no small measure from the fighting reserve of loyal subcontractors which they command.

In the same measure as he has not made his position with the subcontractor unassailable the general contractor has not fortified himself in his function as an adviser and consultant to the engineer and architect. The general contractor is the one to whom they wish to look for the precision of knowledge beyond their general knowledge of practical building. Too often they complain that they do not discover this special knowledge, but must meet the situation unaided. Yet the best contractors do meet the requirement, and again their strength with architects and engineers and in business is their reward.

The general contractor has a function in modern construction. The services he performs must be performed. They may be delegated to other agencies, but they cannot be eliminated. They are best performed by one who is in business to perform them. Neither the owner nor his architect or engineer is in this business. The separate-contract system merely inducts these agents into activities for which they are not trained and have no desire. If the system is endangering the general contractor, the means of safeguarding himself are to improve his standing as an employer and as a construction expert. The engineer and architect will welcome him in this higher postion of efficiency.

At the same time they may wisely at times turn to separate contracts. There is no logical reason, for example, why separate contracts may not be the very best procedure in constructing the masonry substructure and the steel superstructure of a great bridge. Other construction operations are in the same category. Too broad a claim for general contracts is as false as to urge their uselessness altogether.

Convention Procedure

HOW best can engineering societies handle their ever-increasing technical business? The question troubles every society in the country. All of them are increasing not merely in size but also in the number of subjects demanding the attention of their members, and the problem of giving adequate attention to new subjects as well as making older matter readily accessible is one for which no real solution has ever been proposed.

An interesting special case of this problem is that of the American Railway Engineering Association. It differs from other societies in that all its work is done by committees, and all the sessions at its annual convention are given over to the presentation and discussion of their reports. But, as with other societies, each year sees new demands upon the time of the convention and relatively less time given to discussion. Various proposals for relief were made, and finally the board of direction last year appointed a special committee to consider the subject.

After full investigation this committee has now recommended against all the proposals—such as holding sectional meetings or concurrent sessions at the annual convention, a fourth day's session, or curtailment of the number of reports to be submitted. It favored only an advance in the date for filing of committee reports, in order to give members more time to study them before going to the meeting. Regional meetings and the holding of concurrent sessions at the annual convention were opposed on the ground that such meetings tend to narrow the interest and outlook of members. Curtailment of the number of subjects to be reported on annually by committees was opposed as tending toward limiting the number of members attending the convention, narrowing its whole scope and at the same time restricting progress in keeping the association's manual and proceedings up to date on the subjects excluded from the program.

In general, this reasoning is sound. One cannot attend many conventions of technical societies without gaining the impression that their chief value is in their broadening influence upon those who attend. Meeting with men from other fields or with quite different problems as well as with those having similar or allied problems is one of the major benefits to be derived from such gatherings. Social contacts are made or renewed that are bound to have a broadening effect.

Nevertheless, too much subordination of technical matters to the position of mere formalities in the presentation of papers or reports is bound to be detrimental. In the case of the A.R.E.A., it remains true that the multiplicity of committee and sub-committee reports does stifle discussion, and that their number could be reduced without sacrificing diversity. The consciousness that there is a large number of reports to be considered during the day's sessions keeps many men in their seats who otherwise would like to express their views upon the subjects under discussion. Often it is hearing one man express his views on a subject of mutual interest that inspires another to look him up and establish just the kind of contact that makes such a meeting of great value.

In any convention, fewer papers or committee reports are bound to narrow the scope of the meeting somewhat. But if the change relieves the pressure under which such organizations as the A.R.E.A. work and so stimulates more active discussion and more thoughtful consideration of the subject matter, it will be well worth the small amount of diversity sacrificed in making it. May it not be true that many of our societies are losing in intensity and thoroughness of their work by over-great expansion of their programs?

Redistribution of Residence Population

ANNOUNCEMENT of plans for an apartment house on lower Broadway in New York may perhaps mark the return of well-to-do residential population to the downtown region. Such reversal of the steady trend of several centuries is worth more than passing thought. It is closely related to the growth of city transit complications, as well as to changing habits of living and business. Other cities will find it a matter worth their attention.

"Downtown" is of course only a relative term in so long-drawn-out a city as New York. Many apartments have been built south of 59th St. in recent years. But the new Broadway apartment building is considerably lower down, at Tenth St., opposite Grace Church and Wanamaker's. That is relatively far down town, but it stands out more because it is on Broadway, since to the westward other new apartments are being added to those that have gone up in recent years. These are in the old Greenwich Village section—not so very long ago an outlying residence district of single houses, latterly converted into multi-family houses for artists and writers and those who wish to bask in their light or hide in their shadows.

The total newly housed population from 59th to 34th St. is sufficient to lessen somewhat the burden on the upper subway and elevated lines. The rehousing operations from 34th to Tenth St. may not give much additional relief for a few years to come, but they hold out promise for the not far distant future. It is not too much to imagine that the process may even continue far southward, possibly even to the City Hall district, a blighted district since skyscrapers advancing up Broadway drew business-house occupants in great numbers to the mid-town region, several miles north.

In these days of men of large and far-sighted vision, with immense reservoirs of capital at hand, it would not be surprising, now that large-scale rehousing in lower New York has begun, to see whole blocks acquired south of Tenth St., on the west if not also on the east side of Broadway, and the present blighted districts converted into apartment areas quite as attractive as those far to the north, now attainable only after being herded in subway trains like cattle or hogs on freight trains. If tall business buildings are to multiply along Broadway and in the Pennsylvania, Times Square and Grand Central districts, why not give some of their occupants a chance to live in tall apartments near by rather than in equally high ones miles distant?

The same question, with variations to meet local conditions, applies to the other metropolitan cities of the country.

Practices in Placing Vitrified Clay Liner Plates in Sewers

Philadelphia Building Large Lined Concrete Collector—Other Cities' Methods in Building Lined Precast and Monolithic Sewers

SEVERAL cities have under construction at the present time concrete sewers in which a lining of salt glazed vitrified clay plates, ridged on one side with longitudinal dovetail ribs for bond with the concrete, is being used. In this article are reviewed some of the construction practices involved in placing these liner plates in the sewers. A survey of these practices also elicited a number of interesting opinions with regard to the use of clay liner plates.

Brooklyn, N. Y., long an advocate of lined concrete sewers (all Brooklyn sewers have been required to be lined since 1906), admitted glazed vitrified clay liner plates to its specifications as an alternative for brick

FIG. 1—UPPER DELAWARE COLLECTING SEWER, PHILADELPHIA
Concrete sewer, 11x10 ft., lined with clay liner plates and used as an intercepter for sewage and industrial wastes.

about 1917. In Brooklyn the lining of sewers has been regarded as added insurance against repairs on the theory that a sewer, being out of sight, is grossly neglected and should be as permanent as possible. Since 1924 the practice has spread, notably to Philadelphia, Pittsburgh and Los Angeles, and recently a number of other contracts have been awarded.

The liner plates used are made by a number of manufacturers of vitrified sewer pipe, the clay and method of manufacture being identical with those used for sewer pipe. The standard-sized flat plate is 9x18 in., with a slight variation in the width of curved plates, which are supplied with radii from 16½ in. to 45 in. On each plate are five dovetail ribs, which are designed to provide a permanent bond with the concrete.

General Notes on the Use of Liner Plates—According to a census of the opinions of the engineers in charge of the construction work described in this article, the following are among their important reasons for adopting liner plates: For economy, to prevent scour from high velocities, to prevent disintegration of the concrete from acid or alkali wastes, to provide a resistant against hydrogen sulphide action above the flow line, to provide a lining with as few joints as possible and one that occupies a minimum amount of the sewer cross-section, to supply a smooth invert and consequently one with a maximum

FIG. 2—SETTING INVERT PLATES IN MORTAR, UPPER DELAWARE SEWER, PHILADELPHIA

capacity, for speed of construction and because they can be placed with ordinary labor.

When the plates were first introduced for small sewers, where the radii of plate curvature was small, some warped plates were received on one or two jobs. The engineers in each case reported that this difficulty was soon overcome and that the sewers were completed quite satisfactorily. According to the manufacturers, the technique of burning has now been perfected to such a degree that curved plates can be supplied as uniformly as can the flat plates.

In Philadelphia—A number of sewers incorporating clay liner plates have been installed in Philadelphia since

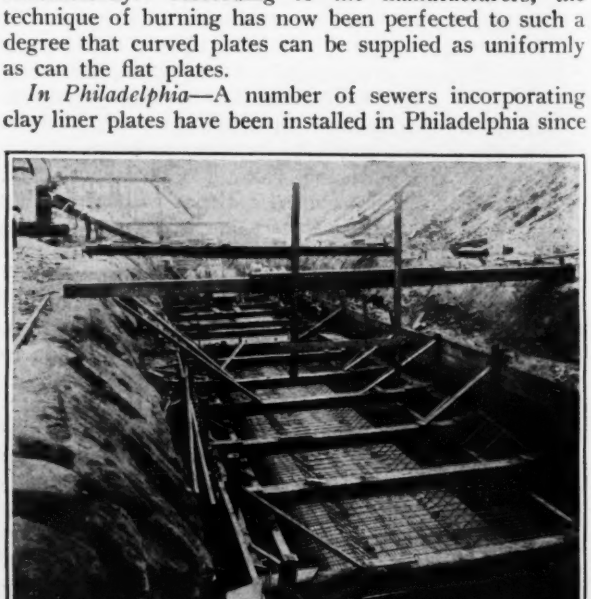


FIG. 3—CLAY LINER PLATES USED AS INSIDE CONCRETE FORMS, UPPER DELAWARE SEWER, PHILADELPHIA

1924. At present there is under construction a large collector sewer, approximately 4½ miles long, paralleling the Delaware River from a point just below the Torresdale filter plant southward to the Northeast sewage treatment plant. This sewer will intercept all sewage that was formerly emptied into the river. It is known as the Upper Delaware collecting sewer and consists of 7,300 ft. of circular tunnel 11 ft. 3 in. and 12 ft. 3 in. in diameter, excavated in gravel and sand under air pressure, and 16,400 ft. of open-cut work. Liner plates are used over the entire inner surface of both tunnel and open-cut sections.

The open-cut work is box section varying from 9x9 ft. to 11 ft. 3 in. x 10 ft. The invert is first poured and then walls and roof are poured monolithic. Following the pouring and setting of the invert slab, liner plates are set on it in a mortar bed about 1 in. thick. The walls and roof are built with special movable and collapsible forms, to which the liner plates are wired; in effect, the liner plates comprise the inside forms for the sewer. The steel framework of the forms is sheeted with boards 9 in. wide, the width of a liner plate, in order that the plates may better be fastened to them. The contractor has devised a clip and wire fastening, as shown in Fig. 4, by means of which two men can very rapidly place the plates; one man on the outside sets the liner plates with the clips and pushes the wires through the forms, while another man on the inside tightens the wires with a pair of pliers. The contractor on this section is the Henry W. Horst Company, Rock Island, Ill.

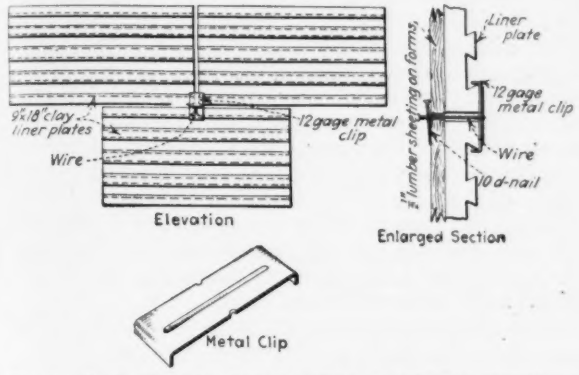


FIG. 4—CLIP USED TO HOLD LINER PLATES IN POSITION, UPPER DELAWARE SEWER, PHILADELPHIA

In the tunnel sections a different method of placing liner plates is being used. The tunnels are driven by an arch-heading method. The forms, semi-circular and of skeleton construction, as contrasted with the solid construction in the open-cut work, are shown in Fig. 5. Thin

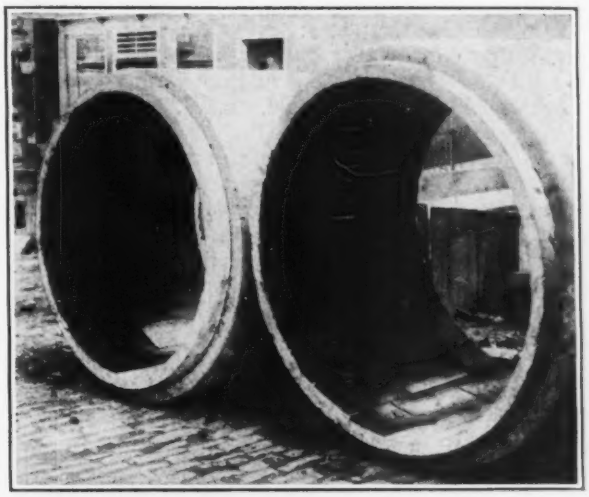


FIG. 6—LINER PLATES IN PRECAST PIPE, NEWARK, N. J.

wires passed between the plates fasten them to slats which are 9 in. apart on the form framework. Concrete in the arch is placed by compressed air between the tile liner plates and the steel liners holding the excavation. For the lower half of the tunnel the liner plates are fastened to the semi-circular forms, with the forms in an inverted position. The forms are then turned over and supported on a concrete block in the bottom of the tunnel until the concrete is poured. Contractors on the tunnel sections are the J. P. White Engineering Company, Passaic, N. J., and Mason & Hanger, New York City. After completion of the sewer and removal of the forms, the plates are cleaned and the joints pointed with mortar.

In Allentown, Pa.—Concrete sewers, circular in cross-section, laid on the Main and Jordan Sts. trunk system of Allentown, Pa., have been lined with plates over the lower half of the circumference. The following method

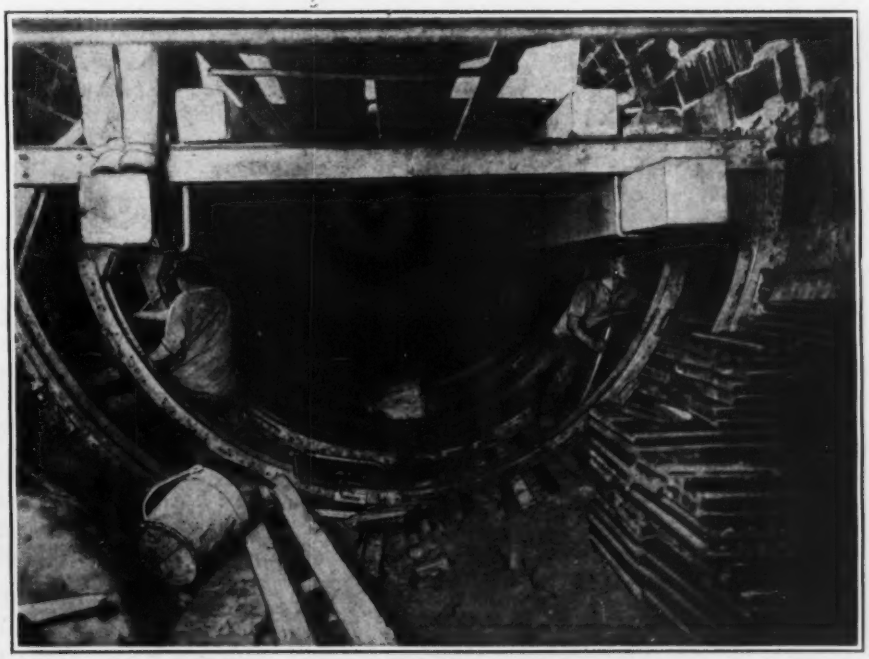


FIG. 5—SETTING SKELETON FORM SUPPORT FOR LINER PLATES. TUNNEL SECTION, UPPER DELAWARE SEWER, PHILADELPHIA

Plates were fastened to the outside of this skeleton and acted as forms for concrete poured behind them. Note that plates are in place in upper half of arch.

is used in laying the plates: After the concrete invert has been poured and allowed to set for 24 hours, a layer of 1 : 2 cement-sand mortar ¾ in. thick is spread and the plates are laid to grade by hand. E. W. Meckley is the city engineer.

In Gloucester, Mass.—Liner plates are being used in Gloucester, Mass., to line completely an intercepting sewer built of precast reinforced-concrete pipe, 36 in., 30 in. and 27 in. in diameter, the plates being cast as an integral part of the pipe. Scored plates which could be split to the required dimensions are used for filler and key plates. Fay, Spofford & Thorndike, Boston, are consulting engineers.

In Newark, N. J.—There is under construction a 60-in. and 72-in. reinforced-concrete pipe sewer as one of the main sewers of Newark, N. J., in which, because

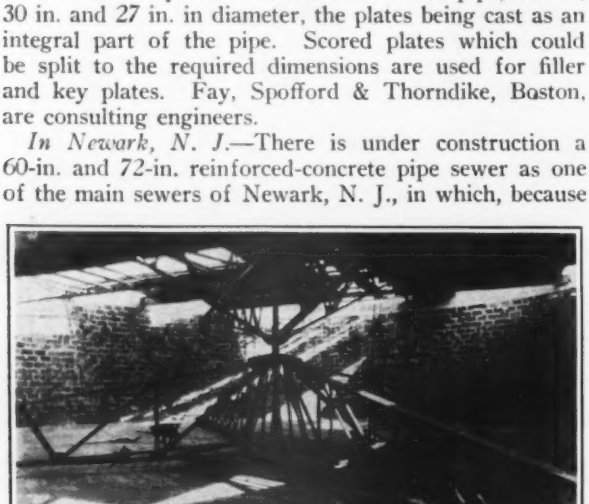


FIG. 7—LINER PLATE INSTALLATION IN SLUDGE DIGESTION TANK, EASTON, PA.
On the walls the liners were fastened to the forms by brads driven through tin roofing caps placed at the corners of each plate.

of a 6 per cent grade, it was thought wise to line the pipes up to the spring line with vitrified clay liner plates.

In manufacturing the pipe, the inside form is set up and oiled and the 9x18-in. plates are placed around the form in such a manner that every other plate on the bottom is a small plate. In this way the circumferential joints are not continuous. The plates are held in place by letting the reinforcement cage hug the liners on the lined half and by wedging the reinforcement away from the form on the unlined half by means of wooden strips shoved down between the reinforcing and the form. These wedges are pulled out after the concrete has been poured. As the cage settles back to its normal position, it allows mortar to surround the rods next to the liner plate. Edward S. Rankin is engineer in charge.

In Easton, Pa.—The entire inside of a sludge digestion tank, 75 ft. in diameter and 18 ft. deep, at the Easton sewage-works has recently been lined with vitrified clay liner plates. The plates were held on the forms by tin roofing caps placed at each corner of the plate, the roofing caps being fastened by brads later cut off. D. Douglas Andrews is chief engineer, bureau of water-works and sewage.

In Baltimore—Recently a 13x6½-ft. box sewer was built in which tile liner plates were used. Bids were received on a square-foot basis on both brick and liner plates with the requirement for lining plates that enough concrete be included to provide a 4-in. thickness, as would be the case for brick laid on edge. According to Milton J. Ruark, sewerage engineer of the city, the low bid was submitted on liner plates.

Engineering Work of Indiana State Conservation Department

AN OUTLINE of the engineering operations of the state conservation department of Indiana was given recently by Denzil Doggett, assistant state engineer, in a paper before the Indiana Engineering Society. The following abstract covers the main points of the work. —EDITOR.

THE Indiana Department of Conservation as organized in 1919 had five divisions: Geology, entomology, forestry, lands and waters, and fish and game. In 1921 an engineering division was added, which has now a permanent staff of five men, with four to seven extra during the summer for field work on park surveys. This division is under W. K. Hatt, who, as head of the school of civil engineering at Purdue University, is state engineer, ex officio. Richard Lieber is director of the department. The engineering division collects information on drainage and flood protection, as well as on other phases of reclamation; makes stream gagings, is making a drainage survey of Indiana, and is investigating the effects of drainage in the Kankakee Valley. It is frequently called upon to advise as to the general plan of a drainage or a levee project, its soundness from an engineering standpoint, and the best method of attaining a desired result with given conditions.

About 30 stream-gaging stations are in operation all or part time. Tabulation of all stream flow data gathered since 1922 will soon be completed. A drainage survey of the state was undertaken to enable the division to assist in reclamation drainage matters. The greater part of this survey was made in 1923, when a field force of three engineers was sent to practically all of the counties of the state and information on local drainage was obtained. County maps showing complete drainage systems have been completed for 83 of the 92 counties. At the same time farmers, bankers, engineers and attorneys were interviewed as to the efficiency and practical value of present drainage laws.

Because of complaints that drainage had been overdone in the Kankakee Valley, the division started an investigation of the effects of the intensive drainage operations there. It is endeavoring to find for the various types of soil a relation between ground-water levels, soil moisture content, rainfall and runoff. The field work, conducted from May to October, consists of: (1) daily readings of eleven rain gages, (2) semi-monthy water-level readings of 165 shallow wells in five lines across the valley from near South Bend to the Indiana-Illinois state line, and of ditches crossed by these lines of wells, and (3) semi-monthly soil moisture samples taken at about 40 points.

The greater part of the engineering service rendered to other divisions of the Department of Conservation has been for the division of lands and waters, which has supervision of state parks and charge of maintenance of lake levels. The park service of the division has been boundary surveys, topographic maps, location surveys and roads and buildings, plans for water supply and sewage-disposal systems, incinerators, swimming pools, beaches, boat harbors, bridges and tennis courts. In many cases the division has also superintended the construction work. Water supply and sewage disposal for the state parks are under the supervision of J. D. Diggs, as sanitary engineer for the department, and the engineering division co-operates with him in this work.

Screened Drains for Engine Terminals at Chicago

Illinois Central Railroad Places Bar Screens on Catchbasins and Ashpit Outlets to Prevent Clogging

IMPROVEMENTS in catchbasins and ashpits at engine terminals have been introduced by the Illinois Central Railroad at its 27th St. engine terminal, Chicago, to eliminate much of the trouble that occurs from clogging of the drains and railway sewers with ashes and sludge. At this place there is no clogging of the city sewers, as the railway drainage is discharged into a 16-ft. intercepting sewer in 39th St.

Catchbasin With Screen Chamber—At engine houses the catchbasins become filled in a short time, and as it is difficult to clean them out, the men in charge are likely to knock a hole in the pipe elbow or trap connection on the outlet in order to let the water run into the sewer. This converts the catchbasin into a plain manhole and removes the protection intended to keep dirt out of the drains, so that they gradually become clogged. Even where traps are maintained, there may be such a large amount of matter carried in suspension as to necessitate frequent cleaning of the drains. This is difficult and expensive, and reconstruction is sometimes necessary.

To avoid this trouble at the Chicago terminal two new catchbasins have been built to receive the drainage from the roundhouses. Each of these catchbasins has a screen chamber built integral with it and forming a trap to the outlet. In addition, the main chamber has at the top an opening large enough to admit a small grab-bucket handled by a locomotive crane, with which the accumulated dirt can be removed quickly and easily.

In the design shown by Fig. 1, the 5-ft. basin has a trap or screen chamber 2x3 ft., with an outlet fitted with an iron screen and tapering to the 12-in. pipe drain. A cast-iron frame and cover on the catchbasin gives a square opening 3x3 ft. for a grab-bucket. The screen chamber also has a cleanout cover, and the tapering outlet to the drain facilitates the use of rods if the pipe should become clogged. The screen, sliding in angle guides, is made of bars $\frac{1}{4}$x1$\frac{1}{2}$ in. fastened together with rods and having washers serving as separators (see Fig. 2).

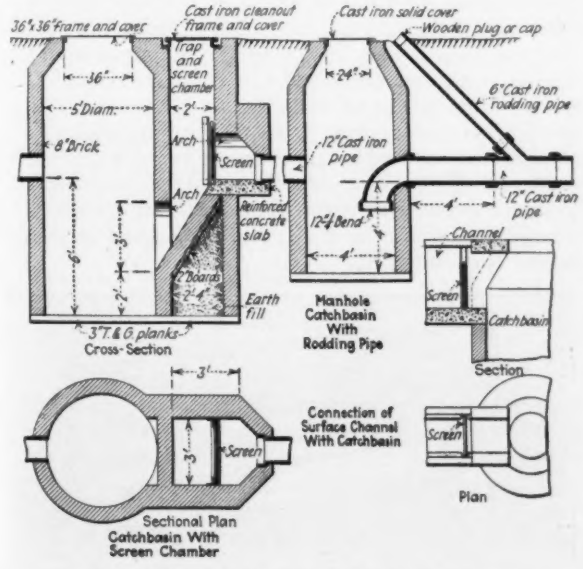


FIG. 1—CATCHBASINS FOR EASY CLEANING

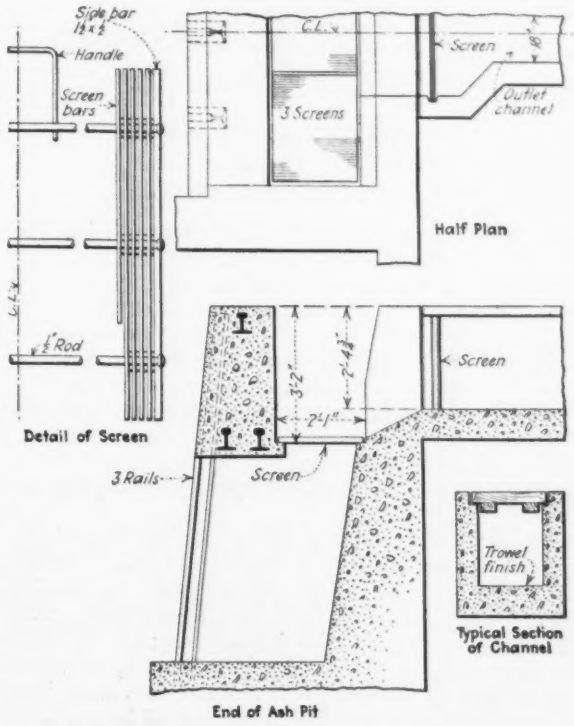


FIG. 2—ASHPIT DRAINS AND SCREENS

At some intermediate combined manholes and catchbasins a cast-iron elbow is used as a trap, a construction that makes it difficult to clean the outlet pipes. To meet this situation an inclined rodding pipe is put in, from the drain to the surface of the ground, where it is fitted with a removable plug or cap. This construction is also shown in Fig. 1.

Ashpit Screens—At this terminal there are three water-type ashpits on a track leading to the engine house, with overflow pipes that originally were connected to catchbasins with sewer outlets. In order to reduce the amount of dirt and cinders getting into the sewers, the overflow channel is now a concrete trench connecting the three pits and extending from the last pit to a catchbasin connected to the general drainage or sewer system. This arrangement is shown in Figs. 1 and 2. The trench is 18 in. wide and averages 26 in. deep. It is fitted with a plank cover made in 6-ft. lengths, so that whenever necessary the trench can be opened for shoveling out the accumulated dirt.

Water-borne dirt carried toward the ashpit overflow must pass first through a horizontal screen at the end of the pit and about 8 in. below the level of the trench bottom. At the upper end of each trench and at the catchbasin connection there is a vertical bar screen fitted to angle-iron guides. All these screens are made of $\frac{1}{4}$x1$\frac{1}{4}$-in. bars set on edge and separated by washers so as to give openings $\frac{1}{4}$ in. wide. Any material passing the screens is so fine that it is carried off with the water.

These drainage devices, which have proved successful in service, were designed by C. H. Mottier, engineer of design, and were built under the direction of D. J. Brumley, chief engineer of Chicago terminal improvements, Illinois Central Railroad.

Devices That Aid Laboratory Studies on Concrete

Permeability, Plastic Flow, Volumetric Changes and Other Characteristics Observed With Aid of Novel Devices

RESEARCH on portland cement concrete has been carried on in the materials-testing laboratory of the University of California under the direction of Prof. R. E. Davis for the past three years to obtain data on physical characteristics of various mixes under various conditions, based on tests extending over a period of years. Temperature and humidity control in rooms of this laboratory used for storing the specimens was described in *Engineering News-Record*, March 8, 1928, p. 395. The following relates to equipment and devices that have made possible the widely varying scope of this investigation.

The subjects to which attention is being directed particularly in this part of the laboratory work are (1) plastic flow under constant sustained load as affected by age at loading, intensity of stress, richness of mix, gradation of aggregate and moisture conditions; (2) Poisson's ratio and modulus of elasticity as affected by age, richness of mix, gradation of mix and moisture conditions; (3) expansion and contraction as affected by gradation of mix, richness of mix, water ratio and variations in moisture conditions; (4) thermal expansion as affected by the character of aggregate, mix, age and moisture conditions; (5) permeability as affected by richness of mix, thickness of test specimen, age and integral waterproofing compounds; (6) strength as affected by temperature at time of test and by continued alternate freezing and thawing.

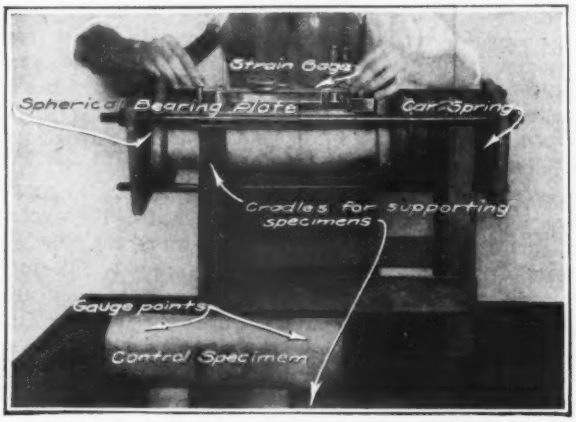


FIG. 1—COMPACT DEVICE FOR MAINTAINING COMPRESSIVE STRESS

Investigation of the plastic flow of concrete due to a constantly applied compressive load is considered of importance because it appears that, accompanying flow, there is a marked redistribution of stresses in many structures as time goes on.

Plastic flow is being observed on test cylinders, 4 in. in diameter and 14 in. long, on the sides of which were set at the time of pouring three pairs of brass plugs, each pair being 10 in. apart and separated by central angles of 120 deg. Later rustless steel contact posts are screwed into these plugs. These specimens are maintained for long periods under compressive stresses ranging from 200 to 1,200 lb. per sq.in. From time to time the spacing of the 10-in. gage lines as defined by the steel contact posts is measured by a fulcrum-plate strain gage in order to record the change in length.

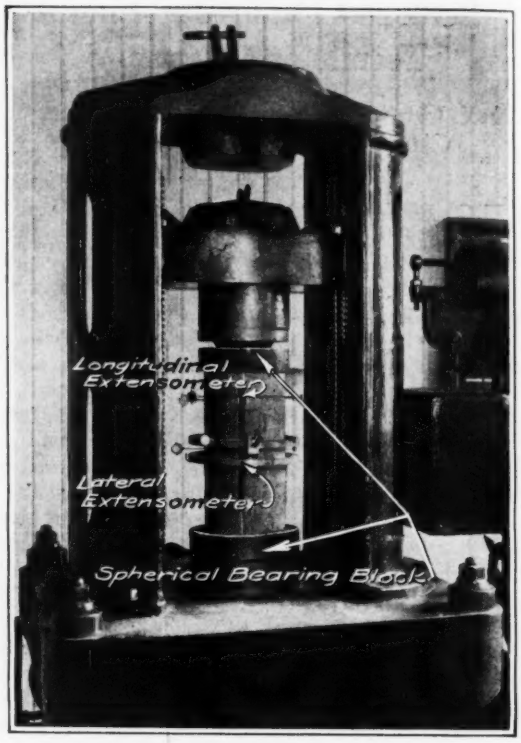


FIG. 2—MIRROR EXTENSOMETERS FOR POISSON RATIO DETERMINATIONS

The apparatus devised to maintain the compressive stress on these specimens consists of car springs, plates and tie rods assembled in the manner shown in Fig. 1. The desired stress is secured by placing the completely assembled device, with the test specimen in place, in a testing machine. Load is applied, flexing the car springs and compressing the test specimen until the desired loading is read on the scale beam of the testing machine. The nuts on the tie rods are then tightened to a firm bearing and the load on the testing machine is released. The specimen is thus left under the compression of the springs, which were stressed to a definite amount. The deformation in the tie rods and in the concrete is so small when compared with the total compression of the springs that the load on the concrete remains practically constant. This scheme has the advantage over the use of levers and weights that the specimens are compact and a large number can be stored in a small space or readily moved for testing, etc.

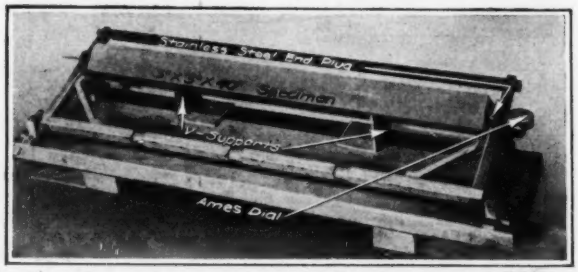


FIG. 3—MEASURING VOLUMETRIC CHANGES AND THERMAL EXPANSION

The strain gage used in determining the plastic flow is of such refinement that deformations can be read directly to 0.00001 in. and by estimation to 0.000001 in. per inch of gage length. To eliminate any change in length from causes other than that due to the constant load, check readings are taken upon the unloaded control specimens, and these are compared with those made on the loaded specimens. All cylinders are kept continuously at 70 deg. F., some being stored in water, others at 70 per cent relative humidity. Four groups now under test were loaded at the age of two days, seven days, 28 days and three months respectively.

For determination of Poisson's ratio and the modulus of elasticity, longitudinal mirror extensometers of the usual type are used and special lateral extensometers of the mirror type were devised to measure deformations on 6x12-in. cylinders within 0.000001 in. These are of a design similar to that developed by Prof. A. N. Johnson and use two aluminum collars bearing on oposite sides of the cylinder held together by springs. Two small mirrors are attached to round rods resting between the collars, one on either side of the specimen, and as the specimen deforms under load the resulting relative displacement of the collars rotates the mirror rods, causing a change in the scale readings, which is observed through a telescope. The same apparatus, shown in Fig. 2, is also used to determine the effect of age upon the modulus of elasticity. Tests have extended over three years.

In studying the effects of moisture on volumetric changes, the specimens used are concrete bars 3 in. square and 40 in. long with rustless steel plugs embedded in either end. As these specimens age under different moisture conditions, changes in length of the bars are observed by a special 40-in. extensometer. (See Fig. 3.)

This device consists of a wooden base on which are mounted V-shaped supports for the specimen and a rigid rectangular frame mounted on two bearings so that it may be rotated down over the specimen. One of the end plugs in the specimen is brought into contact with a fixed point at one end of this frame and an Ames dial fastened to the opposite end of the frame is thrust against the opposite end plug. The length of the frame is frequently checked by means of a standard length steel bar.

Similar 3x3x40-in. specimens are used in determining the thermal expansion of concrete. These specimens are stored in a room where the temperature can be varied at will from 10 to 135 deg. F. Changes in length are measured by means of a 40-in. extensometer similar to that just described except that it is compensated for temperature changes by a combination of Invar and cold-rolled steel such that the extensometer itself is not subject to changes of temperature.

Permeability tests are made on flat concrete disks of several sizes—namely, 18 in. in diameter and 4 in. thick and 12 in. in diameter by 1, 2 or 3 in. thick. The 12-in. disks have a maximum aggregate of $\frac{3}{8}$ in. Each disk is clamped between an upper and a lower plate by an arrangement in which heavy rubber gaskets prevent leakage of the distilled water applied under constant pressure over the top surface of the disks. The arrangement used to secure this effect is shown in Figs. 4 and 5. The bottom of the specimen rests on two concentric annular sheet metal rings between the lower plate and the disks. This lower plate has a central hole so that a knife-edged funnel may be clamped tightly against the lower surface of the concrete to collect the water that comes through the area. This is measured and analyzed for dissolved mineral content.

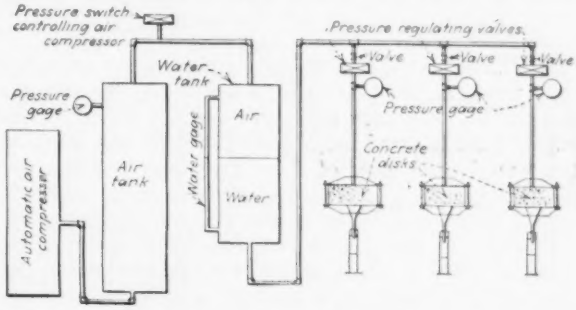


FIG. 5—SCHEMATIC DIAGRAM OF ARRANGEMENT FOR TESTING PERMEABILITY

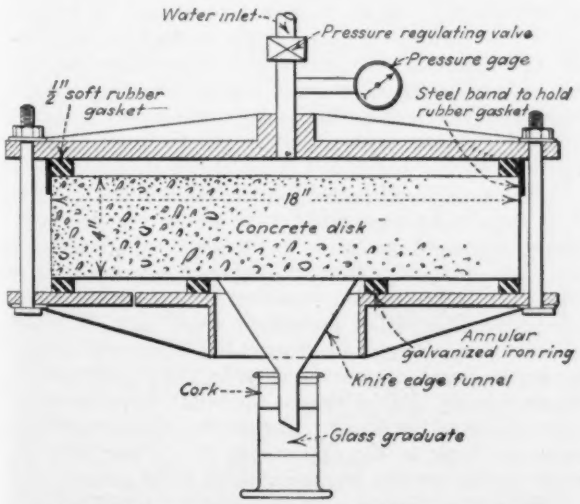


FIG. 4—DETAILS OF THE PERMEABILITY TEST APPARATUS

Developments in Producing Gases for Welding

Large users of industrial gases such as oxygen, hydrogen and nitrogen may be justified economically in making these gases themselves, according to F. P. Wilson, Jr., writing in the *General Electric Review* for March. While acetylene and the electric arc have until recently been supreme in the welding and cutting field, Mr. Wilson believes that such developments as atomic hydrogen welding and the use of city gas and molecular hydrogen in cutting may challenge the supremacy of acetylene. Oxygen, he points out, will be used in ever-increasing quantities for cutting. In fact, the growing use of these gases "may result in an economic adjustment in the present system of gas manufacture and distribution."

Mr. Wilson then continues: "Oxygen can be economically produced from the air by means of air liquefaction and subsequent fractionation, a physical process, or by the electrolysis of water, an electrochemical process. In the former case nitrogen is a byproduct in the ratio of four volumes to one volume of oxygen. In the latter case hydrogen is a byproduct in the ratio of two volumes to one of oxygen. The purity in both cases is 99 per cent or better, but the electrolytic process gives higher purity for both gases when produced simultaneously." These conclusions are understood to be based upon extended research the General Electric Company is conducting.

EIGHTH OF A SERIES OF ARTICLES

Today in the Mississippi Flood Area

Engineering and Human Conditions in the Basins and Along the Levees as an Engineer Sees Them

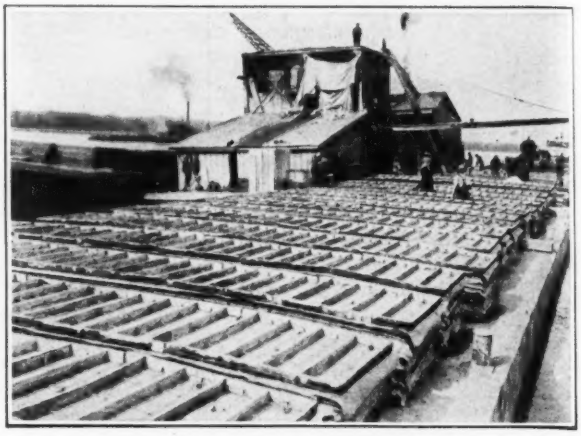
VIII—Revetment and Some River Hydraulics

By W. W. De Berard
Associate Editor, Engineering News-Record

LEVEES alone, revetments alone and contraction works alone as the remedy for the problems of the Mississippi, each and every one has had its advocates. Literature of the Mississippi River Commission, the American Society of Civil Engineers, *Engineering News, Engineering Record* and other technical papers is replete in the early days with articles advocating some one of these works as the full solution of the problem. There is also, to one who digs long enough, plenty of sound river hydraulics that has kept in mind the necessity of all three, with perhaps others. Always until now there has been the lack of funds for the undertaking of the job as a whole. While this article proposes to deal principally with revetments and a particular phase of revetments—that is, the concrete mat—first will be presented a brief discussion of river hydraulics and the place revetments are to play in attaining the ideal section—or, more truly, the practical approach to it.

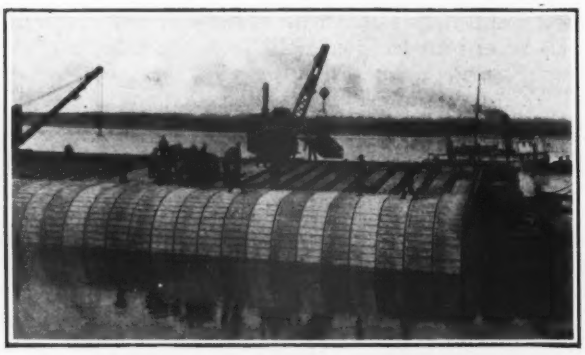
Why Channel Work—An ideal section of channel for the Mississippi River for uses which we now need would be one which within its natural banks would just contain the maximum flood flow and also would maintain at low-water stages sufficient depth at all points for shipping. The practical fact, however, is that the flood flow must be carried by overbank structures, levees so far as they are feasible, then spillways and diversions. The river has not completed its channel. Geologically, mankind appeared on the scene too soon. So to protect those bordering fertile areas, most of the time naturally safe from overflow, and to maintain navigation of the stream at dry-weather stages, both overbank and underbank work must be done by man. If the works to bring about the two principal objectives can be co-ordinated so that one assists the other, efficiency will be promoted and the end accomplished that much sooner; in simpler language, if the high-water stream can be put to work to assist ameliorating low-water difficulties, that is the thing to do.

What are the difficulties at these opposite ends of the flow cycle? At high water it is lack of channel size, shape, alignment and slope to carry the runoff south to the Gulf of Mexico without setting it out on the sidetracks in reservoirs or shunting it into unsuccessful competing channels of prehistoric days. At low water it is a superabundance of channel left in somewhat haphazard shape, alignment and slope by the vagaries of the floods. In an alluvial stream the width is too great at the crossing of the *thalweg*, or thread of the stream from near one bank to the opposite bank. These bars are made by the current impinging against the concave side of the curve, digging a deep channel so hydraulically efficient that the velocity is fast, and carrying the caved



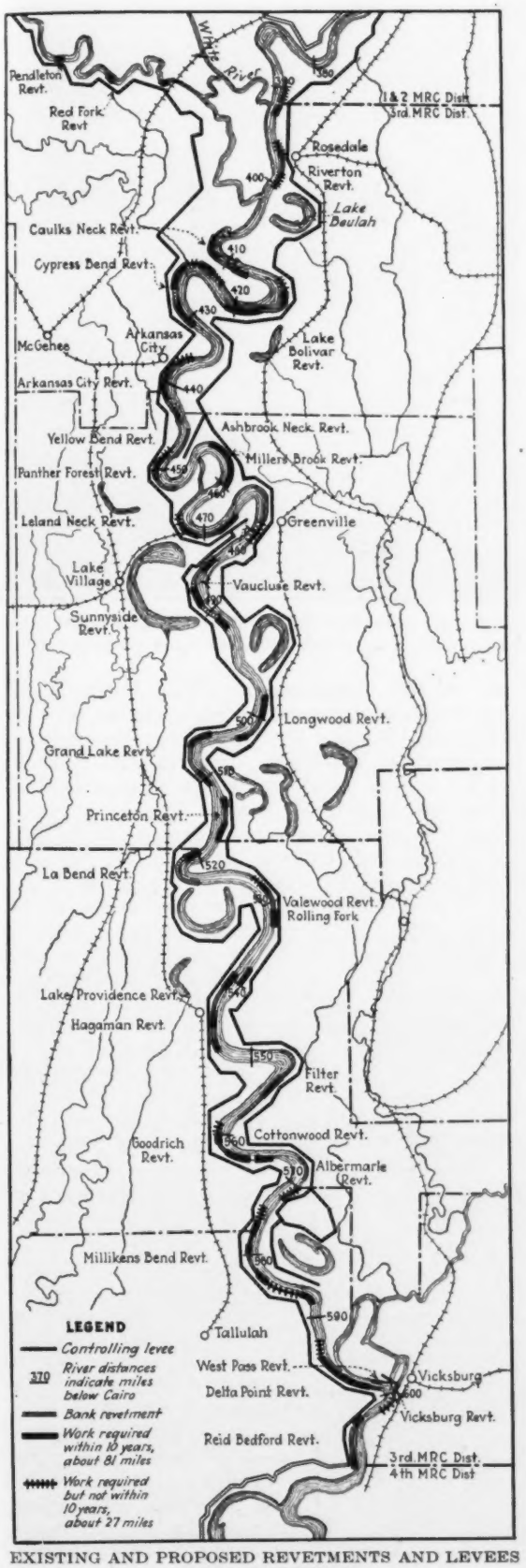
CASTING PLANT FOR CONCRETE MATS

Mixer plant on barge between aggregate barges and barges on which mats are cast one above the other. The 1-yd. paver with boom has a record of mixing 75,000 bbl. of cement in six months without shutdown for repairs. Two sheets of Kraft paper keep slabs from sticking.



CONCRETE MAT-LAYING PLANT WITH SERVICE CRANES

Two traveling cranes lift mat sections from barges on which mats are cast and place them on the roller-bearing skids. The mat-sinking barge moves away from the shore as the mat is paid out over the curbed skids, the separate slabs cracking apart but held together by reinforcement.



EXISTING AND PROPOSED REVETMENTS AND LEVEES IN THIRD DISTRICT

In addition to the above 108 miles surely required, about 65 miles more may eventually be needed.

material away to the wide, inefficient low-velocity bar section. In effect this makes a series of pools and rapids with the velocity fast in the pools and slow in the rapids.

Velocities—Effective discharge comes from velocity which is induced by slope. Slope in general must conform to the bed elevations, but in deep channels an increased slope is largely a function of excess water entering the upstream end. Flood-wave crests are transmitted extremely fast in deep and efficient channels such as that from Baton Rouge to the Gulf—at rates ranging from 6.9 ft. per second at Baton Rouge to 25.2 ft. per second at New Orleans. In more inefficient sections, such as at Lake Providence, the transmission is 4.3 ft. per second, and at Helena it is 3.9 ft. per second. James A. Seddon, assistant engineer, discussed this subject fully in the 1892 report of the Mississippi River Commission, page 2907. Beyond a supposition that the variation in rates of transmission depends on the relative lengths of pools and bars, possibly combined with slope and mean depth, Mr. Seddon did not connect the variation with any physical cause. He does say, however, that "in translation all pressures acting through the mass are considered as expended simply in the acceleration of velocities of flow, or in normal slope effect; while in transmission we consider that an element of the pressure may cause a vertical motion which changes the form of the free surface, as in the movement of a plane wave." From Baton Rouge down the travel is one of transmission, for it exceeds the known bounds of possible translation and lies fairly within the range of tide movements up an estuary. Above Baton Rouge the travel across pools is transmission, but it is slow, and is coincident with translation across shoals.

COMPARISONS BETWEEN TRAVEL OF FLOOD WAVES AND MEAN VELOCITY AT BANK-FULL STAGE

Reach From Preceding Gage	Length Reaches, Miles	Time Interval, Days	Travel of Flood—Miles Per Day	Travel of Flood—Feet Per Sec.	Mean Velocity, Bank-full Stage Ft. Per Sec.
Cairo	0.0	0.0	.....	.....	.....
New Madrid (Plum Point)	70.8	0.6	118.0	7.20	4.67
Fulton*	104.6	1.1	95.1	5.80	4.74
Memphis	54.6	0.6	91.0	5.55	5.00
Helena (Arkansas River)	76.5	1.2	63.7	3.88	5.10
Arkansas City*	131.8	1.6	82.3	5.03	5.24
Greenville	40.2	0.3	134.0	8.17	5.08
Lake Providence	63.8	0.9	70.9	4.33	5.02
Vicksburg	57.0	0.8	71.2	4.34	5.13
Natchez	101.0	1.3	77.8	4.74	4.93
Red River Landing	65.0	0.9	72.2	4.40	4.72
Baton Rouge	68.0	0.6	113.3	6.91	5.00
Carrollton	123.7	0.3	412.3	25.15	5.43

* The reaches in the commission's report, New Madrid to Plum Point and Helena to Arkansas River, are respectively taken as New Madrid to Fulton and Helena to Arkansas City to correspond with reaches for which the intervals have been determined.

The accompanying table gives comparisons between travel of flood waves and mean velocity at bank-full stage (carrying 1,000,000 sec.-ft.).

Increase in mean depth, it seems, will increase the rate of flood travel and promote a more rapid and unimpeded discharge of flood waters. Practically this means that the desired objective is to be attained by (1) cutting down 100 to 150 shoals by contraction works, and fixing the location of the river by revetment in both low and high water, and (2) retaining between levees the excess over bank-full stages.

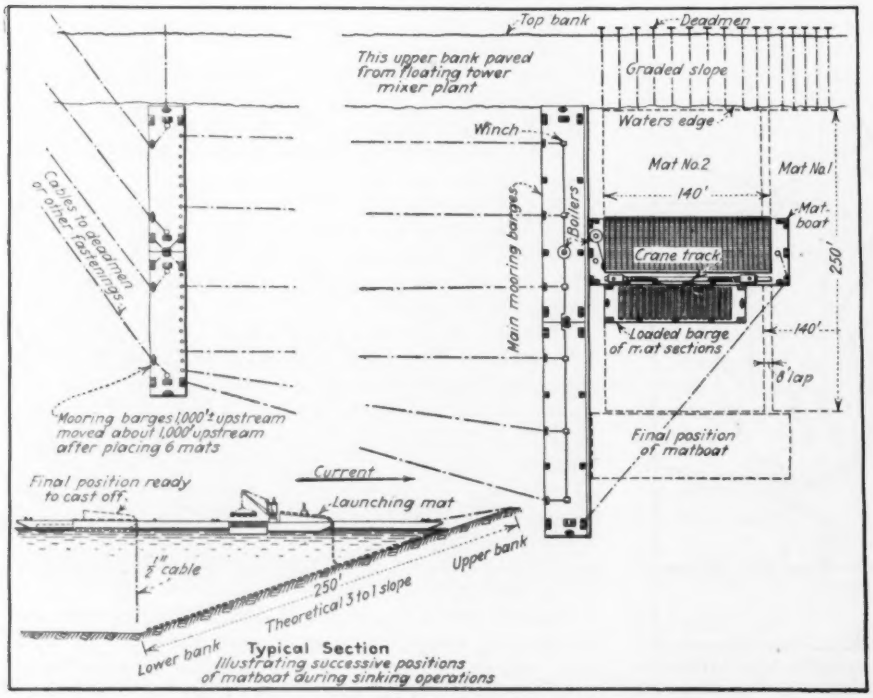
Eads' Work—Capt. James B. Eads, in 1886, wrote an illuminating analysis of the need of the river in high water, which, briefly stated, was to attain uniform high-water channel. Three means were available: (1) contraction works properly placed in the wide portions of

the river, (2) levees alone, (3) bank protection or revetment and levees. As Captain Eads was a firm believer in the efficacy of permeable dikes, he placed contraction works first, as being rapid, certain and economical. Levees only he considered equally certain, but slower and more expensive. The addition of revetment as then practiced he considered uncertain and still more expensive. But with contraction works and levees he claimed that in three years a reduction could be secured from Cairo to the Gulf and a low-water depth of 20 ft. above Red River maintained. He wanted $30,000,000 to $40,000,000 and six to eight years to complete the job. Only about $2,000,000 was voted by Congress, however.

Experiments were made. The permeable contraction works did the work; the channel was deepened, but it was not permanent unless revetment was applied to the concave side. These conclusions are in an 1886 report of the Mississippi River Commission to the Secretary of War. Since then it has been generally conceded that permeable contraction works and bank protection must go hand in hand. In fact, so well established is the theory that in the present controversy over flood-control methods there is heard no dissenting voice as to the engineering of the revetment program, although one-third of the amount asked for in the recommendation of the Chief of Engineers is for revetment. Not even in the field or on the river does this question of river training by means of stabilized caving banks get any criticism.

Straightening—In detail: As to overbank alignment of levees, and as to spur dikes and contraction works, there is mild discussion up and down the valley by the thinking type of hydraulic engineer. Not much serious difference of opinion arises until river straightening by cutoffs through bends is proposed but then plenty of argument arises. First, they say, let us stabilize the river where it is, and if it will not dig a deep enough channel to stay within its levees, we shall then have time enough to give it more slope by shortening its length through straightening. Which brings us back to a comparison of the senile efficient channel with high velocity and low slope below Red River, and the channel upstream of Red River, which has twice as great a slope but with its irregular overbank cross-sections and pool-and-bar longitudinal sections exhibits a low net velocity. Wave crests can be transmitted in the lower river, starting high velocities rapidly at the outlet end. At the upper end the wave crest transmission is rapid over the pool sections but is slowed up at the bar sections, hence transmission velocities are not much in excess of translation or mean velocities; the mid-section gets choked and is compelled to carry a larger crest quantity than does the New Orleans section.

LIFTING A MAT SECTION FROM MATERIAL BARGE
Hooks on lifter engage reinforcing wires in every other section.



PLANT FOR SINKING CONCRETE REVETMENT MATS

Bank revetment, then, which will enable permeable contraction works to be effective, which in turn will narrow and deepen the low-water channel over the bars and increase the velocity, gets $100,000,000 without question.

In just what shape the Mississippi River Commission is to take on work of this kind forms the subject of the remainder of this article.

Revetment History—Revetment in the early days took three forms: (1) the continuous mattress, (2) the submerged spur, and (3) the spur extending to the highwater line. Here only mattresses will be discussed.

In 1881 the first revetment work was started, consisting of brush-and-wire mattress. The method of operation was to revet the bank below water, grade the bank to receive the upper bank protection and then place the upper portion. Many failures are recorded. Willows have been the stand-by material, woven into framed mattresses or brush rafts and fascine mattresses with the fascines placed normal or parallel to the current. By 1896 the Mississippi River Commission had concluded "that in a plan for the permanent improvement of the channel by the contraction of its low-water width the work of bank protection should precede the permeable dikes and other structures of that class, and that the latter may be regarded as supplementary in function and as necessary only in a minority of cases."

The problem was complicated at this date, 1896, with the fact that supply of enough willows had become difficult. The supply available from Cairo to Vicksburg was estimated as sufficient only for making fifteen miles per year of revetment. Board mattresses were tried and proved a failure. Bricks, tried in place of stone for sinking, fell through and were lost. The manufacture of concrete blocks was undertaken first in 1899. Today blocks are cheaper than stone.

Concrete Paving—In 1909 the feasibility of concrete paving, reinforced with wire mesh, was assured and five years later the district officers were directed to use concrete for upper bank paving instead of rock wherever it was efficient or economical.

Concrete Mattress—In 1914 an allotment of $2,500 was allowed for an experimental revetment of 4-in. concrete slabs launched from barges in 10 to 40 ft. of water. Five slabs were 14x18½ ft., two were 40x100 ft. and one 19x48½ ft. A diver found them intact and effective. Major E. M. Markham, district engineer in charge of the First and Second Districts, where the experiments were tried, developed a plant to manufacture sheets or gigantic shingles 125x50 ft. by 4 in. thick and launch them from inclined decks. The plant for this shingle type was put into operation in 1922. Plant for making and laying this type, but of much smaller shingles, developing a method devised by Col. G. M. Hoffman, then a member, M.R.C., has been developed in the First and Second Districts, and the writer hopes to describe it later on.

Meanwhile the Third District had been experimenting, and in 1922 A. M. Todd, assistant engineer, submitted a report on an articulated type of concrete mat consisting of slabs 3 in. thick, 11½ in. wide and 3 ft. 11 in. long strengthened and connected by wire reinforcement of 12x12 in. mesh. In building this mat the reinforcement was cut in strips 25 ft. long, and 25 slabs were cast in each mat unit. Numerous improvements have been made in the casting and laying methods and apparatus, but the principle has remained practically as originally developed.

TRAVELING BITTS SECURE MAT AND MOORING BARGES
Like a barn door hanger on its side, the traveling bitts run in the slot of a box girder on the mooring barge.

SMOOTHING OFF 1 : 2 : 3 CONCRETE WITH WIDE HOE
Concrete made in accordance with P.C.A. best practice from graded aggregate.

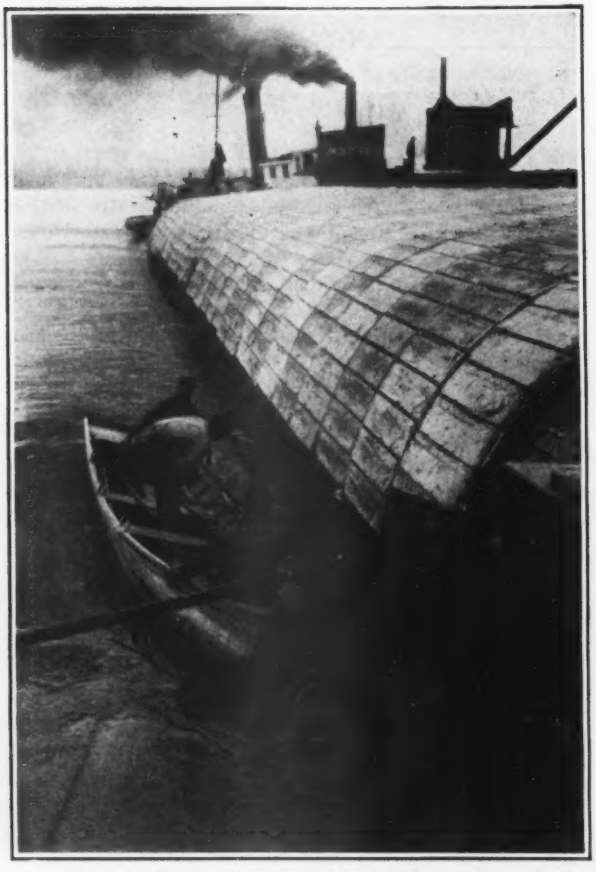
Manufacture of Articulated Mats—Mats are cast on barges one on top of another after about six hours' curing, one or two sheets of Kraft paper being laid over the green slab to prevent sticking. In winter the curing time is twelve to twenty-four hours. The manufacturing plant consists of a quarterboat, a gravel and sand dredge, two or more gravel barges, a floating concrete-mixing barge equipped with a 1-yd. mixer and a boom to reach over the 30-ft. barges; and from six to twenty-four standard material barges. Steel barges hold 308 units and wooden barges 254 units fourteen to twenty-one layers high.

In operation six or more material barges are moored end to end near a gravel bar. The floating mixing plant travels up and down the line of barges, filling the mat forms in succession. This part of the work has been speeded up so that in February, when the plant was inspected, it had been so synchronized that everything worked with surprising regularity. Two ten-hour shifts were being worked, and an hour-glass with the sand running through in two minutes marked the time of 1¼ minutes for mixing, and ¼ minute each for discharging and filling. About 500 batches were discharged per day, indicating a lost time of but 100 minutes in 600 minutes total. The average number of squares for a month has been 545, with a maximum of 640. In the last six months the mixer plant has been down for repairs only six hours, the cause then being a broken water pipe.

About 75,000 bbl. of cement used in 1:2:3 mix concrete has gone through the mixer without repair, which is believed to be a record. The bottleneck in the system is in the number of barges, as it takes a week to fill a barge and another six days before the greenest slabs can be removed. The round trip for the barge is 21 days. The district has 81 barges, but only 50 can be allotted to this service. Since the tie-up in barges has become so apparent, schemes have been studied for casting slabs on shore during high-water periods when mats cannot be laid.

As to method of laying, Mr. Todd described the mat-sinking plant and sinking procedure in a recent bulletin of the Mississippi River Commission, some extracts from which are embodied in the following paragraphs.

Mat Boat—The mat boat is constructed entirely of steel, with hull 170x54 ft. by 9 ft. deep, on which skids are erected (4 ft. on centers) with a slope of 1 vertical to 8 horizontal. The skids extend over the edge of the barge in a circle with radius of 8 ft. The edge of the barge for its full length is made with a rake under the ends of the skids so as to permit its being hauled in close to the river bank. Ball-bearing rollers are placed alongside the skids. At one end of the boat there is a boiler house with a 60-hp. upright boiler. On the side of the barge opposite to the curved skids there is a full-length machinery alley, and on posts at the machinery end of each skid there are mounted two grooved friction drums. Each drum has eight grooves and passing through the grooves is a ½-in. wire strand cable leading from a reel just under the skids through direction sheaves and through the friction drums in eight figure 8 turns, thence through a sheave at the top of the skids and alongside of the skids to the shore, where groups of the cables are fastened to dead men or trees. There are 36 skids and 36 pairs of friction drums, each pair of drums being geared together by spur gears. A worm gear actuates each pair of drums, the worms being driven from countershafts. The first countershaft actuates a group of six pairs of friction drums. Each of the other countershafts actuates a group of five pairs of drums. A main shaft, which runs the entire length of the machinery alley, is driven by a double cylinder 5½x6-in. reversible engine with train of gears. A slip spur gear from the main shaft through the proper ratio of gearing to each countershaft actuates the group operated by that countershaft, which may thus be cut in or out at will. Ordinarily when the mat is being paid out, all friction drums are operated and the entire width of mat is paid out at the rate of 5 ft. per minute. It occasionally becomes necessary to sink narrow mats and at times cut out intermediate groups of friction drums.



CUTTING CABLES BETWEEN MAT LAID AND NEW ONE

A 250-ft. section of mat has been laid with outer end in 60 ft. of water. The cables which supported it are being cut and will be knotted to cables running from dead men on shore when plant has been moved upstream to new position.

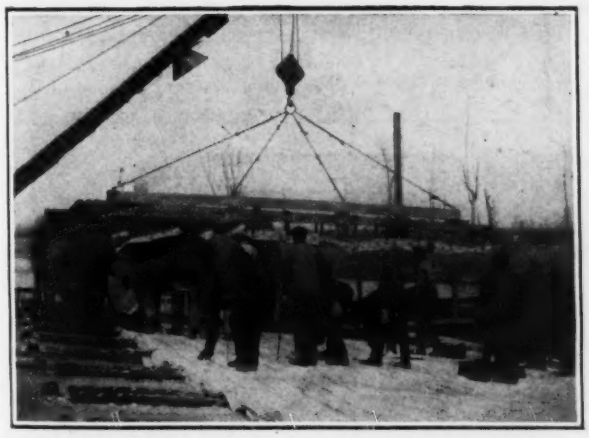
A standard-gage rail track is constructed along the edge of the barge opposite the curved ways. On it are operated two small locomotive cranes used to handle the mat units. The mat boat also has a 6x8-in. steam capstan on each end, a 1-kw. electric light plant, and a locomotive-type air compressor with necessary air connections.

Mooring Barges—Mooring barges are swung out into the stream, normal to the bank, and supported by mooring cables fastened to dead men or trees ashore. The practical problem in connection with the sinking of concrete mats was to support the mat boat in such manner that it would be free to move in or out as the various sections of mat were being launched. This feature gave trouble on the first devices tried. Finally the principle of the barn-door trolley was utilized. The slot and trolley are placed in the horizontal instead of in the vertical plane. The slot is built in the shape of a box girder designed to withstand the application of severe horizontal forces, and the trolleys are reinforced extra-heavy traveling bitts, to which the mat boat is fastened. The mooring barges are equipped also with six powerful steam hoisting engines, each with 1,200 ft. of $\frac{7}{16}$-in. steel hoisting cable. The cables are fastened to an upstream set of independent ordinary mooring barges or other suitable anchorage.

Sinking Operations—In an accompanying illustration is shown the sequence of operations followed to sink the mats in place. The river bank is cleared of timber and the bank hydraulically graded to a slope of not less than 1 vertical to 3 horizontal from top of bank to low water. The concrete mats can be sunk at any time from low water to a bank-full stage. The upper mooring barges are set approximately 1,000 ft. above the lower end of the reach to be revetted. The mat-sinking plant with main mooring barges is swung so as to lay mat 1 (140x250 ft. ±) at the extreme lower end of the work proposed. The mat cables are then made fast ashore, the mat boat being in position as close to shore as practicable. In many cases the full-length rake along the edge makes it possible to lay some of the mat above the water's edge. The cranes now lay up the first section of mat. This consists of 35 mat units, each clipped to the mat cables (which are 4 ft. apart) and to each other by a Crosby

type clip at intervals of about 5 ft., while between clips, at intervals of 1 ft., a substantial twisted wire tie is put on that engages both border wires and the mat cable. Thus there is formed a section of mat 140x25 ft., thoroughly fastened together at intervals of 1 ft. in all directions. This section is launched down until the lower edge is in the water or on shore. Another section is laid up on the skids, attached to the retained end of the preceding section and the launching process continued, while at the same time the mat boat is shifted out along the mooring barges so that the bight of the mat will lie evenly on the bottom without piling up.

These mat sections are formed and launched until a mat extending 140 ft. along the shore and 200 to 300 ft. out into the stream is formed, reaching beyond the toe of slope of the bank being protected. The shifting out of the mat boat and the launching process are continued until the entire width of mat is on the bottom of the river. Each mat cable is then cut at the water surface. The mat-sinking plant is now hauled upstream 132 ft. by means of the steam winches on the main mooring barges and the mat boat shifted inshore to a new setting for mat 2, allowing a lap of 8 ft. on the mat previously sunk. These operations are continued until 800 to 1,000 lin.ft. of bank is covered; the upper mooring barges are then shifted about 1,000 ft. farther upstream and sinking operations continue as before. It has been found that the sinking plant can easily place an average of 700 squares (70,000 sq.ft.) a day—with maximum day's run of a little over 800 squares. For average widths of revetments this covers about 265 lin.ft. per day, or just one mile each working month.



LIFTER DROPPING MAT SECTION ONTO SKIDS

Highly organized gangs tie the mats to a ½-in. cable with clips and wire ties. The two gangs are in competition for the extra time to rest that is gained while waiting for the slowest crew to finish before the barge is started and the slab is paid out into the river, which takes about four minutes.

TREE ROOT HAS SNAGGED OUT PIECE OF REVETMENT

This section covering a pie-shaped opening at a point in the bank has been turned over completely, but the remaining slabs are in place, preventing any scour.

Costs—During the 1927-28 season a total of 67,000 squares was placed, at an average cost of $14.65. Willow mats cost about $2 more per square. The mixing plant invoices the squares to the laying plant at $7. Certain unit costs of manufacture follow: Aggregate, 32c.; paper, 10c.; wire fabric, $1.30; cement, $3 in winter (six sacks) and $2 in summer (four sacks); towing, 75c.; forms 25c. The laying cost runs to $2.65, grading $1, and repairs, surveys and headquarters charge $4. Willow mats cost about $300,000 per mile and concrete $225,000. The principal reason for the difference is that the concrete work can be synchronized and put on a manufacturing basis all the way through. Labor likes the concrete work better than willow work, and work can be prosecuted at all river stages lower than 5 ft. below flood line, which means an active season of nine to ten months. With the funds available, 300,000 squares, or 12½ miles, is probably the outside limit for a full season's work.

Stabilizing the banks in some one place is essential both in low water for navigation and in high water to insure the safety of levees from undercutting. Of the total length of river 790 miles from Cairo to Red River Landing 749 miles were reported as actively caving during the low water of 1907. Caving is not extensive below Red River Landing. Essentially this means that one side or the other requires revetting above the senile river section. The flexible concrete mat offers a physical solution of this first essential toward controlling the river and within a reasonable time. Assuming six months' working time and a mile a month output, a dozen mat plants could fix the banks of the Mississippi in ten years. The cost per plant, according to Col. Charles L. Potter, president of the M.R.C., would be less than $1,000,000.

For five years the sinking plant has been in charge of E. J. Fife, foreman, and the casting plant in charge of C. J. Lawson, foreman. Revetment work in the Third District is in charge of W. M. Childs, associate engineer, reporting to A. M. Todd, senior engineer. All work of the Third District is under Major John C. H. Lee, Corps of Engineers, U. S. Army, as district engineer.

Steel Plates Transfer Stress in Concrete Bridge Truss

Seattle Street Carried Across Ravine on Bridge Built to Half Ultimate Width—Novel Panel Connection Details

IN PLANNING the new Admiral Way bridge across a deep ravine in Seattle it was desired to leave undisturbed the existing wood trestle that occupies half the street width and also to keep the investment in a new structure down to the minimum required by present traffic conditions. It was therefore decided to leave the existing wooden trestle in place and to build beside it on the remaining half of the street width a concrete structure designed so that later the wood trestle can be removed and duplicate half of the concrete structure put in.

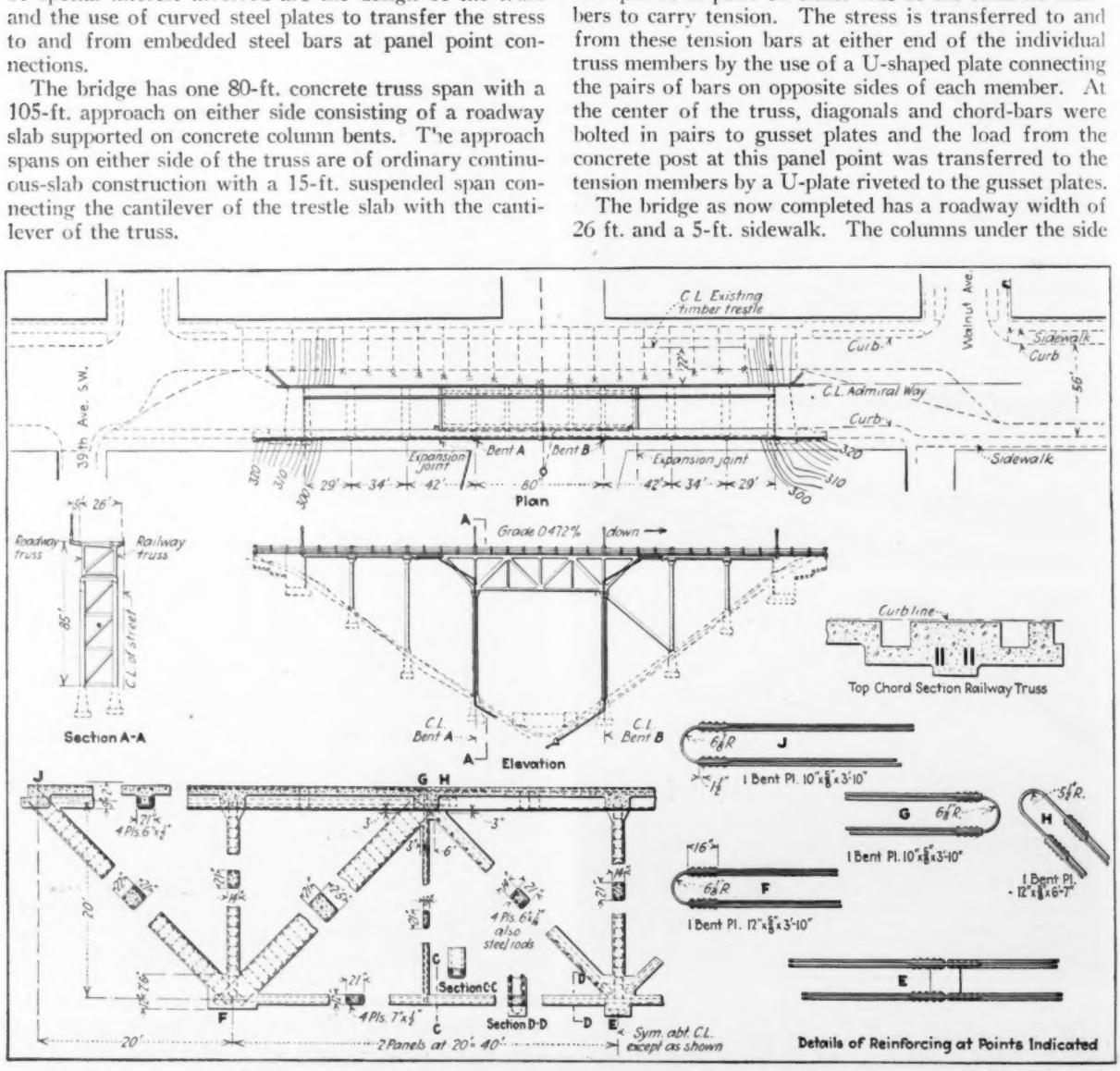
The cost of a reinforced-concrete bridge worked out, on a long-term basis, well below that of a structural-steel bridge, and concrete was accordingly selected. Points of special interest involved are the design of the truss and the use of curved steel plates to transfer the stress to and from embedded steel bars at panel point connections.

The bridge has one 80-ft. concrete truss span with a 105-ft. approach on either side consisting of a roadway slab supported on concrete column bents. The approach spans on either side of the truss are of ordinary continuous-slab construction with a 15-ft. suspended span connecting the cantilever of the trestle slab with the cantilever of the truss.

ADMIRAL WAY CONCRETE TRUSS AT SEATTLE
Note wooden trestle of half street width in background.

The truss was designed using 7x½- and 6x½-in. steel bars placed in pairs on either side of the concrete members to carry tension. The stress is transferred to and from these tension bars at either end of the individual truss members by the use of a U-shaped plate connecting the pairs of bars on opposite sides of each member. At the center of the truss, diagonals and chord-bars were bolted in pairs to gusset plates and the load from the concrete post at this panel point was transferred to the tension members by a U-plate riveted to the gusset plates.

The bridge as now completed has a roadway width of 26 ft. and a 5-ft. sidewalk. The columns under the side



PLAN, ELEVATION AND TRUSS DETAILS, ADMIRAL WAY BRIDGE

of the structure nearer to the center line of the street were designed to support one of the two railway tracks to be included in the ultimate structure, and the design is such that the present structure can safely carry street cars on the single track already laid.

The columns supporting the central truss are octagonal in section and about 65 ft. high. In order to prevent any separation of the aggregate in pouring these columns and also to avoid excessive impact on the forms due to dropping concrete through this height, the columns were poured through a pipe the bottom of which was kept buried in concrete. In other words, the pouring method corresponded to the use of a tremie as ordinarily employed in subaqueous delivery.

The bridge is divided into three longitudinally fixed parts by two expansion joints, one on each side of the truss span. The two end sections are held in position longitudinally by connection to the abutments and the center section is held in position by a longitudinal brace from the top of one of the column bents to the adjacent pier. The Admiral Way bridge was designed by the bridge department, city of Seattle, under the direction of A. Munster, bridge engineer, to whom *Engineering News-Record* is indebted for these data and illustrations.

Large-Section Tunnel Construction at Asheville

Section 48x27 Ft. Opened by Widening Center Heading and Taking Out Bench in Two Lifts, Using Power Shovels and Cars

By E. L. Hageman
Howerton Engineering Company, Asheville, N. C.

A ROCK tunnel of unusually large section is being constructed at Asheville, N. C. Inside the concrete lining the section is 39 ft. 2 in. wide and 22 ft. high, which means an excavation section approximating 48x27 ft. The purpose of the tunnel, as indicated by Fig. 1, is to give a direct entrance to the city for road traffic from the east (Highway No. 10), to bypass the through traffic around the business section by the way of Woodfin St. and to give direct connection between the city and a developing section east of the ridge now accessible only by a tortuous route the two ends of which are indicated on the plan. The project, which has been talked about for a number of years, took material form early last year, when surveys and plans were made, and a contract for the tunnel was let May 16, 1927.

Tunnel Structure—As shown by Fig. 1, the tunnel is 920 ft. long and on a tangent. At each end there is an open cut held by retaining walls, and from the portals about 90 ft. of the west end and 40 ft. of the east end of the tunnel are in soft material requiring timbering. The remainder of the excavation is solid rock. The approach to the tunnel from the east is on a rising grade of 5.75 per cent; through the tunnel the grade is —0.3896 per cent, and at the west portal the grade increases to —3.922 per cent, connecting with Woodfin St. Extension at its intersection with Poplar St., Fig. 1. The section of the tunnel is shown by Fig. 2.

As specified, the portals and lining are concrete, using stone crushed from the excavated rock and purchased sand, and using 5 per cent of diatomaceous silica for waterproofing. Fig. 2 shows the lining reinforcement. In the earth section it will be noted that the lining extends to the underside of the lagging; this yardage beyond the neat line of the tunnel ring is to be paid for at the same price per cubic yard as the ring concrete. In the rock section the corresponding extra concrete yardage receives three-quarters the price of the ring concrete. Where permanent timbering is necessary, 12x12-in. longleaf yellow pine timber rings spaced 24 in. are required, as shown by Fig. 2.

The lighting system as now planned consists of three rows of 200-watt lamps so spaced that each 30-ft. section of tunnel will contain one lamp, one row in the center of the roof and one 45 deg. on either side, a total of 34 lamps within the tunnel. These will be countersunk, with R.L.M. standard dome reflectors, mounted directly on ceiling outlet boxes. In addition there will be seven lamps on each portal entrance mounted on standard cast-iron lighting posts of suitable design. The group of lamps near each portal entrance will minimize the change from bright sunlight to the less brilliant diffusion within the tunnel. The remaining lamps are to be burned in such combinations as to produce a constant illumination of sufficient strength to guarantee traffic safety. All groupings are to be automatically controlled. An electric conduit will be placed under the sidewalk, as

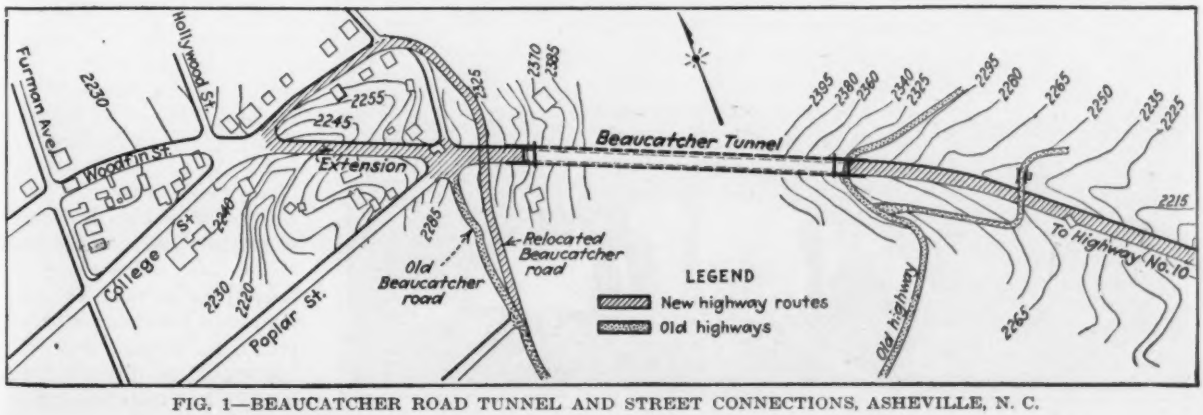


FIG. 1—BEAUCATCHER ROAD TUNNEL AND STREET CONNECTIONS, ASHEVILLE, N. C.

shown in Fig. 2, with side connections running up through the tunnel lining to serve the lamps. Under the opposite sidewalk will be placed a telephone conduit, and on both sides under the sidewalk will be laid a 10-in. tile drain with inlets from the gutter. Also 4-in. tile drains, 20 ft. on centers, extend through the tunnel wall from the back and drain into the 10-in. tile beneath the sidewalk.

No provision has been made for ventilating the tunnel, as it is at the peak of the grade and will of itself produce sufficient draft to expel all monoxide gas that would tend to collect in sufficient quantities to create a traffic menace.

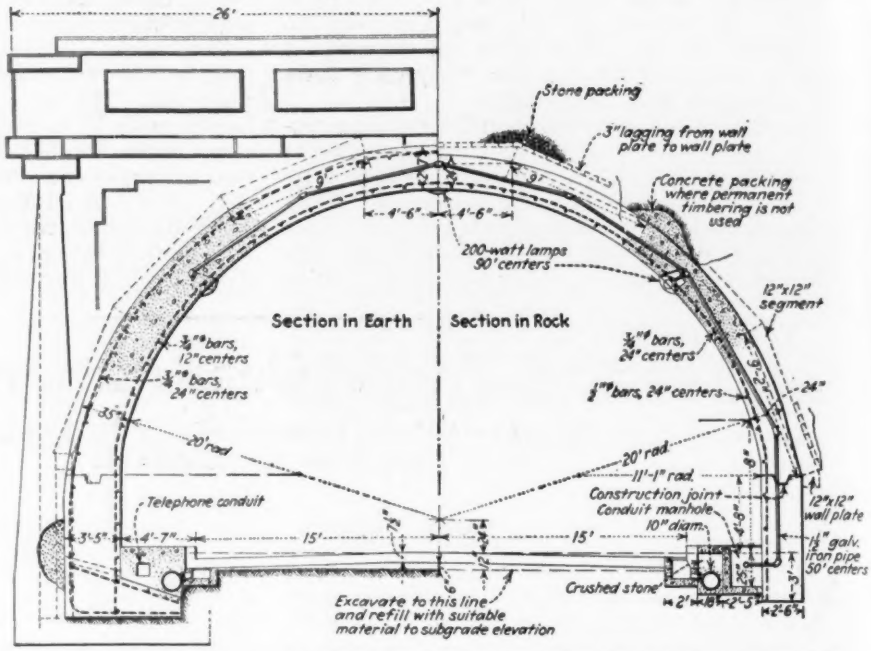


FIG. 2—SOLID ROCK AND SOFT GROUND SECTIONS FOR BEAUCATCHER TUNNEL

Construction Methods—The contract, as awarded, includes open-cut excavation at both approaches amounting to 42,000 cu.yd. The east approach cut was removed first, using a ¾-yd. steam shovel, the material being hauled in 3½-ton trucks and deposited in the roadway fill beyond the cut. Some delay was experienced in this operation, because a wet, rain-soaked subgrade made truck haul very difficult at times. Securing the necessary right-of-way within the city limits retarded operations at the west portal, and the approach cut at that end was not removed until after the completion of the east approach cut, the material being placed by trucks in the fill immediately adjacent, which forms a part of the Woodfin St. extension.

The tunnel proper was begun at the east portal immediately after the completion of the east approach cut by driving two drifts 5x8 ft., one on each side of the center line, the bottoms being at the bottom of wall plate grade. The drifts were carried back a distance of about 50 ft., beyond which it was estimated permanent timbering would not be needed. The timber rings were then placed, beginning at the outside ring and placing successive rings as the material could be removed, leaving the core in place, Fig. 3, on which to brace the segments of the rings as they are being assembled. After timbering for 40 ft., sufficient solid rock cover was obtained to be self-supporting. A heading 8 ft. high by 12 ft. wide, Fig. 4, was then started along the center line of the tunnel, reaching to a point 2 ft. above finished roof grade.

After completing the heading indicated as Section *A* on Fig. 5 the remaining sections, *B*, *C* and *D*, will be removed in the order given, the sections being carried back in steps to facilitate drilling and shooting. The muck taken from the east heading is being dumped in the cut and will later be picked up by the shovel, hauled back through the tunnel and placed in the Poplar St. fill. All sections except *A* will be worked from the west end and be handled by the large shovel.

A heading is also being driven at the west portal. Some difficulty is being experienced here, as heavy rains have loosened the soft overburden, resulting in repeated small slides, but nothing of a serious nature. A unique method of placing the permanent timbering was employed at this portal. The two side drifts, Fig. 6, were driven as before and two 18-ft. wall plates were placed on each side in the drifts. The rings were then placed, beginning at the back and working out toward the portals. The plan is to have sufficient timbering placed to support the overburden before disturbing the unstable material directly over the portal and thus de-

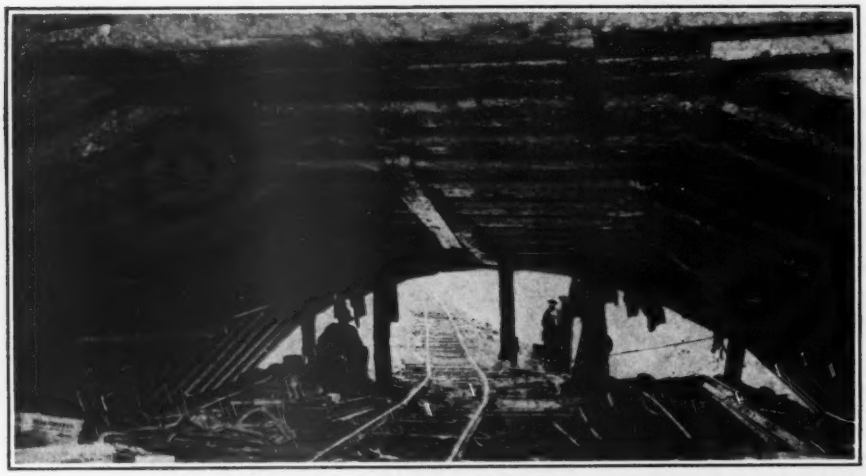


FIG. 3—TIMBERING IN SOFT GROUND AT EAST PORTAL

crease the possibility of further slides.

Construction Plant — The material from the main bore of the tunnel will be moved with a power shovel and transported in 6-yd. standard-gage cars pulled by a 21-ton steam dinky. At the east portal air is supplied by an electrically driven compressor, which supplies 220 cu.ft. per minute to the jackhammers and drifters and is driven by a 60-hp. electric motor. At the west portal air is supplied by a compressor, furnishing 400 cu.ft. of air per minute and driven by a 100-hp. electric motor. Here, also, are located the crusher, mixer, hoist, cement house, shop, office and camp. The crusher is a No. 5, driven by a 60-hp. electric motor and is equipped with standard circular screens. The derrick has a 60-ft. boom, which can be extended to 80 ft The mixer will discharge into side-dump cars of 1-yd. capacity. The shop is equipped with one oil furnace, one electrically driven pipe threader, one welding machine and one drill sharpener. Steel forms will be used, and an air-driven concrete gun will place the mix.

On account of routing state highways through this passage it is estimated that an average of 7,000 vehicles daily will pass through this tunnel. By building the Beaucatcher tunnel, it is conservatively estimated that the elimination of sharp curves and steep grades and the shortening of distance will save enough money, by a reduction in operating expenses of motor vehicles, to pay for the initial construction cost within five years and will eliminate hazards and reduce traffic congestion.

FIG. 4—CENTER HEADING IN HARD ROCK AT EAST PORTAL

Direction—The contract was let to the Clement-Dunavant Company, of Knoxville, Tenn., and Charlotte, N. C. The subcontractor on the approach excavation is the Asheville Construction Company, Asheville, N. C. W. H. Mapps is superintendent for the construction

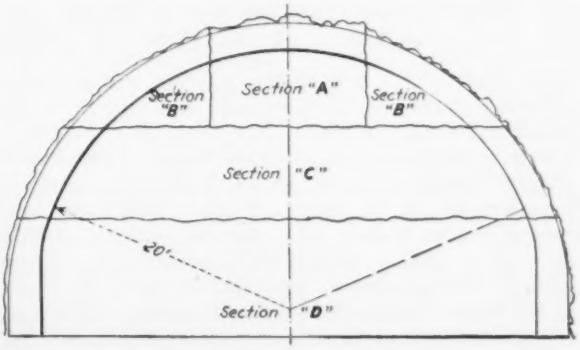


FIG. 5—EXCAVATION SEQUENCE IN SOLID ROCK

company and Paul Lancaster is the engineer. The Howerton Engineering Company, of Asheville, N. C., prepared the plans and specifications for the entire project and represents the city and county in the supervision of construction. The tunnel is to be completed in the early fall of 1928.

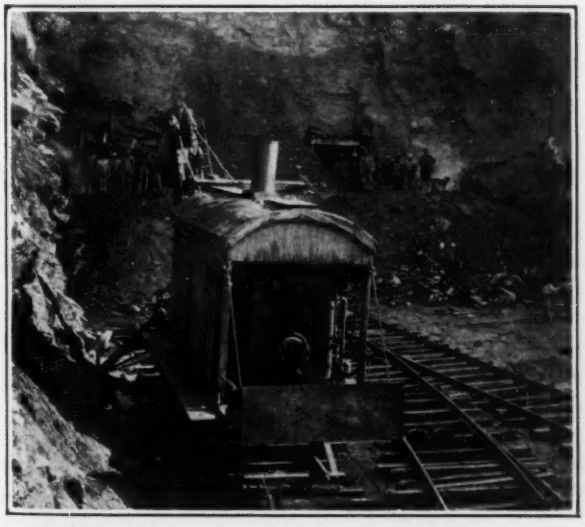


FIG. 6—SIDE DRIFTS AT WEST PORTAL

View after completion of approach cut. The drifts on either side were carried back 40 ft., and 36 ft. of wall plate was laid on each side in the bottom. The timber rings are now being placed at the inside end of the wall plates, working out toward the portal. The material between the drifts has slid down from the top; power shovel in the foreground.

609 Grade Crossings Eliminated in New York State

The annual report of the State Division, Public Service Department, filed with the Governor and both branches of the Legislature of New York, shows that 609 railroad crossings have been eliminated in the state up to the present time under order of the present commission and its predecessors.

During 1926 and 1927, under the grade crossing elimination act, there were 426 proceedings started involving 745 crossings. There were 192 orders directing eliminations involving 338 crossings and 321 orders closing, principally for lack of jurisdiction, proceedings already begun involving 407 grade crossings. There were 52 crossings eliminated.

Designing a High Storage Dam for the Mokelumne Project

Solution of Problems Involved in the Lancha Plana Dam Being Built in California for Water-Supply Purposes

By F. W. Hanna
Chief Hydraulic and Designing Engineer, East Bay Municipal Utility District, Oakland, Calif.

In response to the modern demand for dams of great height, in which maximum safety and economy can be combined, continual progress is being made in the design and construction of dams. The Lancha Plana dam presents several phases of recent progress in both gravity and arch type, because of a change in plan necessitated by foundation conditions at the site. With present-day practice as to underpressure and drainage, the section of the gravity type remained close to the ideal triangle. In the arch type the engineers preferred elastic arch calculation without attempt to divide the load between arch and cantilever action, but unit stresses were kept at low values. In this case the shape was adapted to the conditions by thickening the arch toward the abutments and by building up straight tangential abutments as the structure lengthened out toward crest level. —Editor.

Part I—Governing Features of Design of 360-Ft. Gravity Dam

As part of the Mokelumne River project for a present mountain water supply of 60 m.g.d. and an ultimate 200 m.g.d. supply, the East Bay Municipal Utility District is building the Pardee reservoir, of 213,000 acre-ft. capacity, on the Mokelumne River in the foothills of the Sierra Nevada Mountains near Lancha Plana, Calif. The dam site is located in a canyon the walls of which are composed of a narrow intrusion of metamorphic schist, transverse to the course of the river. Surface inspection indicated sound rock, and at the start an arch dam was therefore considered most suitable for the site. But later foundation and abutment exploration disclosed much overburden, an incipient slide on the right canyon wall, and a narrow, soft stratum across the site about midway of the intrusion, which made an arch dam undesirable. The structure was therefore redesigned as a gravity dam, though a curved alignment was retained.

Since designs for an arch dam had been begun, they were carried to completion, as described in the second part of this article, but in view of the foundation conditions a dam of gravity section, curved on a 1,200-ft. radius, was located downstream from the soft stratum. All things considered, this was concluded to be the most suitable type and was adopted for execution. The following considerations were taken into account in proportioning the gravity section. The maximum height of the dam above foundation is 360 ft.

In addition to the usual requirement that the resultant of the water pressure and masonry weight shall fall within the middle third of any horizontal section, the vertical section was based on the following requirements: (1) The pressure line at any level shall not depart from the vertical by more than a 0.75 slope; (2) the maximum compressive stresses in the dam and in the foundation shall not exceed 500 lb./in.²; (3) the variation of pressure on the foundation shall be taken as rectilinear; (4) the masonry shall be assigned a weight of 150 lb. per cu.ft.; and (5) when the foundation stresses are figured on the assumption of a vertical slice of the dam between parallel planes, the uplift on any horizontal section shall be taken as zero at the toe and 25 per cent of the hydrostatic head at the heel, while for a vertical slice between radial planes the heel uplift was taken at 10 per cent instead of 25 per cent.

The vertical pressures on the foundation and other horizontal sections of the dam for a vertical slice between parallel planes were computed for 50-ft. intervals below the top of the dam. (See table.)

Feet Below Crest	Reservoir Empty Vertical Pressure in Lb./In.² at Heel	Toe	Reservoir Full Vertical Pressure in Lb./In.² at Heel	Toe	Uplift Ratio	Sliding Factor
50	66	5	0	57	0.667	0.588
100	117	−3	0	99	0.334	0.682
150	160	0	0	145	0.259	0.676
200	206	3	0	189	0.258	0.678
250	253	6	0	234	0.266	0.679
300	307	4	0	280	0.266	0.680
250	360	4	0	329	0.263	0.681

The maximum inclined compressive stress at the toe on a plane 350 ft. below the crest of the dam is about 470 lb./in.² and that at the heel, 360 lb./in.²

The dam will contain a 5x10-ft. inclined inspection and drainage gallery paralleling and approximately 30 ft. from the upstream face of the dam. This gallery will contain a drainage channel connecting with a system of 8-in. drainage wells spaced 10 ft. on centers. Vertical radial contraction joints will be provided at 50-ft. intervals. At 5 ft. from the upstream face these joints will contain annealed copper water stops extending in continuous sheets from the bottom to the top of the dam.

The foundation excavation for the dam was nearing completion on Dec. 1 and it was expected that the pouring of concrete would be commenced soon thereafter. Contract for building the dam, which will contain approximately 640,000 cu.yd. of concrete, is held by Lynn S. Atkinson.

Part II—Analysis of Concrete Arch Dam

The original program of the district for the storage dam called for an arch structure, as noted previously. The designs for this dam were worked out in a novel way so that in addition to variable central angles and radii, a variable thickness of the horizontal sections of the arch was effected by means of three centered circular intradosal boundaries. Although the final decision was in favor of a gravity dam because of foundation conditions, the methods of designing the arch, approved by the engineers of the Federal Power Commission, may be useful in solving other problems of a similar nature.

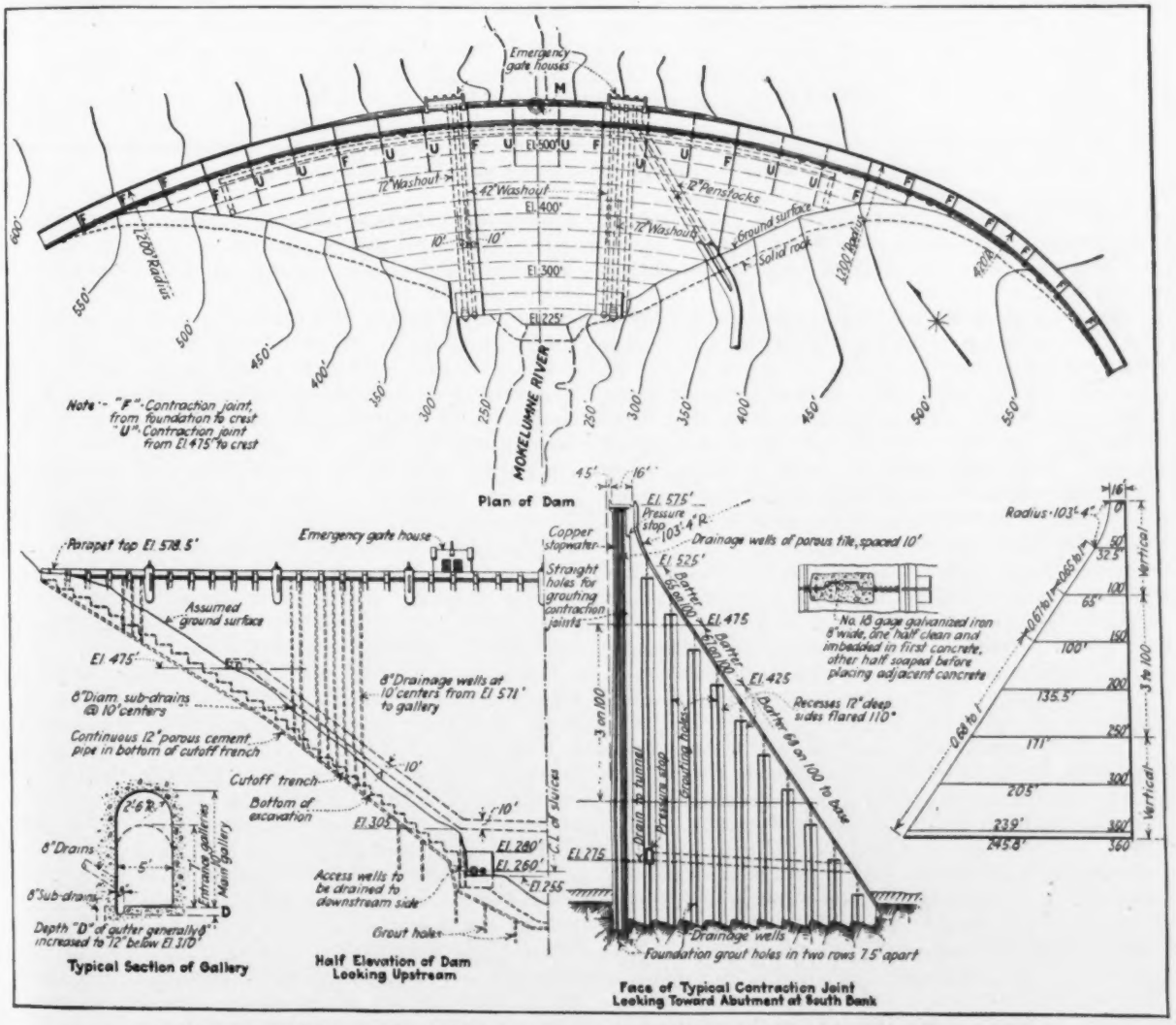
The dam was to consist of a central arch section, terminating in gravity abutments at either end. The height of the maximum section was to be 360 ft., the top width 15 ft. and the total length 1,550 ft., of which 773 ft. was to be in the arch and 777 ft. in the abutments.

The upstream arc of each horizontal section was single centered with a radius varying from 500 ft. at the top to 243 ft. at the bottom, the corresponding central angles varying from 90 deg. at the top to a maximum of 106 deg. near the base. These radii, circle centers and central angles were so chosen as to prevent undercutting and to fit the arch shape to the resultant line of the acting forces. The downstream curve on each horizontal section of the dam, for a distance of 120 ft. down from the top, consisted of a central arc concentric with the upstream arc of the same section, having a radius shorter than the upstream arc by the thickness of the dam, and of two equal side arcs having shorter radii than the central portion.

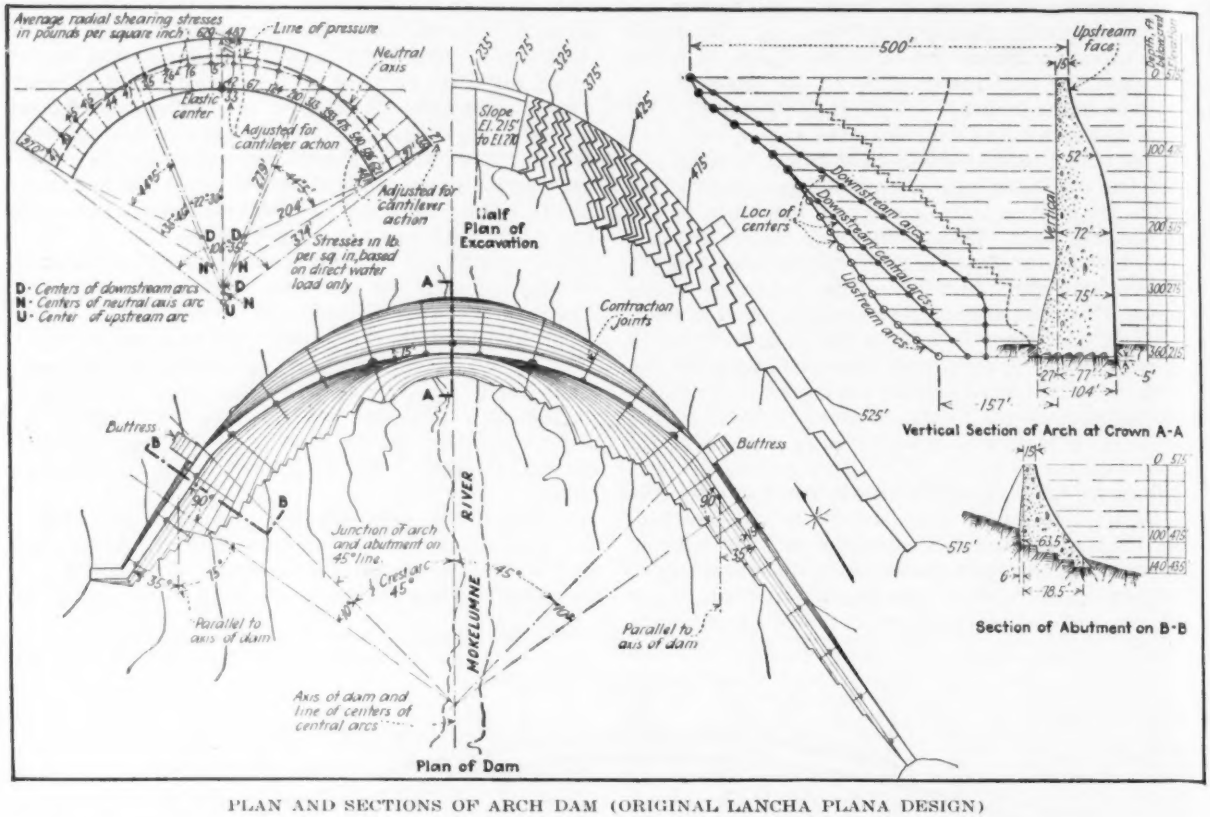
Below the 120-ft. level the central arcs had their centers on the axis of the dam but nearer the dam than those of the corresponding upstream arcs in order to obtain a sharper intrados curve toward the abutments in the lower levels. All of the central arcs were symmetrical about the axis of the dam and had a total central angle of 45 deg. The side arcs ranged from 22½ to 47½ deg. so that the total downstream central angles would range from 90 deg. at the top to 140 deg. at lower levels. The ratios of the side arc radii to the central arc radii ranged from unity at the crest to 0.48 near the bottom. The face of the crown section on the downstream side was vertical from the top down to a level 240 ft. below, and from this point down to the base the face of the arch had a varying slope.

The neutral axis for each section of the dam was fixed midway between the upstream and downstream arcs. The total measured arc range of the neutral axis varied from 90 deg. at the top of the dam to a maximum of 118 deg. at the lower levels. In laying out the dam, angles, radii and centers were determined for the top of the dam and for each 20-ft. interval therefrom toward the base, the surfaces of the sections between these 20-ft. levels being determined by joining the sections.

The abutments were designed with ample proportions and shapes such that the resultant lines of pressure fell well within the toe of the abutment for their entire length and so would prevent the arch from tending to



MAXIMUM SECTION OF LANCHA PLANA DAM, GRAVITY TYPE, AS NOW BEING BUILT


Average radial shearing stresses in pounds per square inch
Line of pressure
Neutral axis
Elastic center
Adjusted for cantilever action
Adjusted for cantilever action
Stresses in lb. per sq. in. based on direct water load only
D - Centers of downstream arcs
N - Centers of neutral axis arc
U - Center of upstream arc
Half Plan of Excavation
Slope El. 215' to El. 270
Contraction joints
Buttress
Buttress
RIVER
MOKELUMNE
Junction of arch and abutment on 45° line.
½ Crest arc 45°
Parallel to axis of dam
Parallel to axis of dam
Axis of dam and line of centers of central arcs
Plan of Dam
Upstream face
Loci of centers
Downstream arcs
Downstream central arcs
Upstream arcs
Vertical
Vertical Section of Arch at Crown A-A
Section of Abutment on B-B

PLAN AND SECTIONS OF ARCH DAM (ORIGINAL LANCHA PLANA DESIGN)

pull the abutments away from the hillside. The axes of the abutments were given the general direction of the arch thrust, a feature considered important in designs of this type.

Maximum allowable working stresses were fixed at about 600 lb./in.² compression and 100 lb./in.² tension, based on the rectilinear theory of stresses with no allowance for Poisson's ratio. It was appreciated that stresses computed on these assumptions would be reduced by the parabolic theory of stresses, the application of Poisson's ratio and cantilever action. The working stresses were fixed at these limits because it was proposed to use concrete with a minimum compressive strength of about 2,000 lb./in.² in 28-day tests.

Stresses due to thrust, moment and shear were computed by the theory of internal work, applying the law of elastic displacements by the use of formulas developed for the purpose. The development of these formulas is the subject of a paper to be published subsequently in the *Proceedings* of the American Society of Civil Engineers.

After the formulas were developed and prior to their application, the Cain formulas for symmetrical circular arch rings loaded with water pressure were used to determine the general shape of each arch section. Each section was then given a variable thickness by trial computations by the elastic displacement method in such manner as to equalize the stresses throughout the section as nearly as possible, the thickness being adjusted to the limiting working stresses as nearly as that was possible.

In these trial computations the tentative arch section, determined as described, was divided into an even number of parts of varying lengths, decreasing from the crown toward the abutments and measured along the neutral axis. The x-axis and y-axis were so located as to make the summation of the moments of the elastic weights with respect to them zero and so as to make the axes conjugate, as is done in the ordinary analysis of elastic arches in bridges. All of the centers, angles and coordinates for these divisions in each section were drawn to a working scale suitable for determining the quantities necessary for evaluating the desired stresses from the fundamental formulas. The stresses as determined from the general arch formulas at the abutments and crown were then adjusted for cantilever action. Both unadjusted arch stresses on the center line of each voussoir and those adjusted for cantilever action at the abutments and crown are shown at the 200-ft. level in the accompanying drawing. This drawing also shows the line of pressure, the neutral axis, and the principal centers and radii for the arch section at this level.

Temperature stresses were also figured by the same general method of analysis used for other stresses in the arch. It was not considered, however, that they would be likely to be coincident with the maximum stresses due to water load, because the dam was to be thoroughly grouted at all of the expansion joints in cool weather. The computations for temperature stresses with empty reservoir were based on a mean variation in the mass concrete of 10.5 deg. F. in the top section to 2.5 deg. F. in the bottom section. The calculated maximum compressive stress was 45 lb./in.², which was in the top section of the dam, and the calculated maximum tensile stress was 52 lb./in.², which was in the section at a level 280 ft. below the top of the dam. These figures were based on an average seasonal temperature range of 30 deg.

French Railway Station Built of Reinforced Concrete

The Paris-Orleans Railroad Incorporates Massive Arches and Beams in Its New Terminal at Limoges

By A. M. Roos
Assistant Superintendent, Société des Grands Travaux, Marseille, France

THE RAILWAY terminal recently completed in Limoges, France, the city of the French porcelain industry, is an example of some of the structures that French engineers are designing and erecting of reinforced concrete. The terminal is 310 ft. by 260 ft. in plan and is built over ten tracks. It is divided into two parts, an outside yard 130x260 ft., where buses and motor cars enter, and an inside hall 180x260 ft., all as shown in Fig. 1. The roofs of both parts are carried over the tracks on continuous beams, spanning 43 ft. between columns 3 ft. 4 in. in diameter. The girders vary from 33 ft. to 56 ft. long, framing into the continuous beams on 11-ft. 3-in. centers. All beams and girders in the open yard are 3 ft. 4 in. square, as are the beams under the hall; the girders under the hall are 1 ft. 4 in. x 3 ft. 11 in. in section.

The accompanying illustrations give an idea of the extent and character of the details of the structure. When the station is completed, the concrete will be faced with stone masonry, white soft limestone for the vertical facing and pink hard limestone for the cornices. The hall is inclosed on three sides by thin walls and on the fourth by a six-story reinforced-concrete building and an eleven-story campanile or tower. The center part of the hall is composed of four groups of four columns, each group supporting two twin arches with spans of

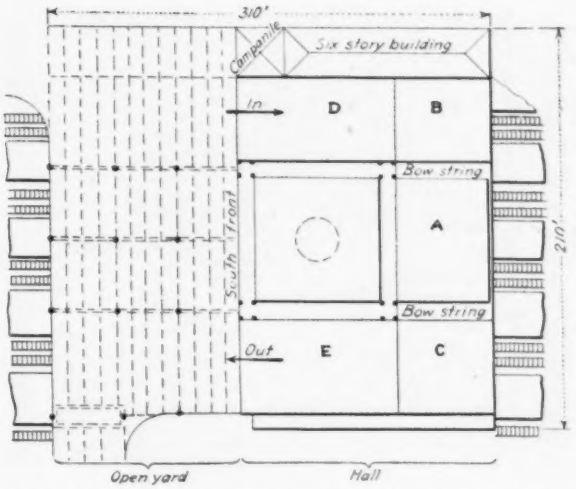


FIG. 1—LAYOUT OF RAILWAY STATION, LIMOGES, FRANCE

86 ft. 10 in. Each arch is a seven-center ellipse, composed of two parallel beams 3 ft. wide by about 11 ft. high. Although first planned as arches, the load reactions were found to be so high that these members were finally designed as horizontal beams resting freely on their supports. Bowstring arches are used between the center part of the hall and the northern front (Fig. 1), these arches having a span of 71 ft., and being 13 ft. 10 in. wide. These bowstring arches frame into a beam across the northern front, which has a span of about 80 ft. and carries a load of about 450 tons (its own weight of concrete and facing stone plus about 100 tons from the roof).

The roof spanning between these beams and arches consists of structural steel framework covered with two

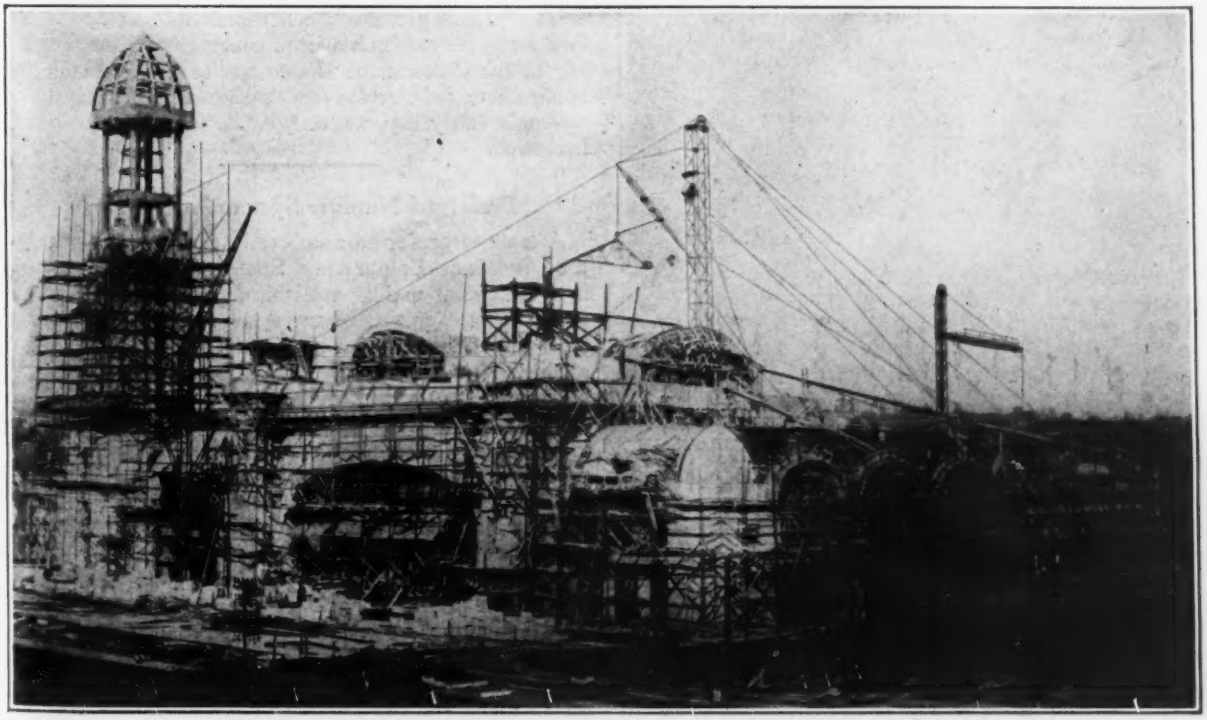


FIG. 2—CONSTRUCTING A REINFORCED-CONCRETE RAILWAY TERMINAL IN LIMOGES, FRANCE
The work was characterized by massive details and complicated formwork.

FIG. 3—CONCRETE ABUTMENTS FOR THE STRUCTURAL STEEL DOME OF THE LIMOGES (FRANCE) RAILWAY STATION

layers of $\frac{3}{4}$-in. plank on top of which are copper sheets $\frac{1}{32}$ in. thick. On the outside of this metallic covering an ornamental design similar to the covered structural framework is used. The roof over the two side aisles is covered with blue slate and all of the flat or low-curved parts of the roof with lead $\frac{1}{8}\frac{3}{4}$ in. thick. For handling the water runoff, 0.15 sq.in. of pipe is provided for each 10.7 sq.ft. of roof surface.

In the eleven-story tower each floor consists of square slabs 14 in. thick supported by four beams resting

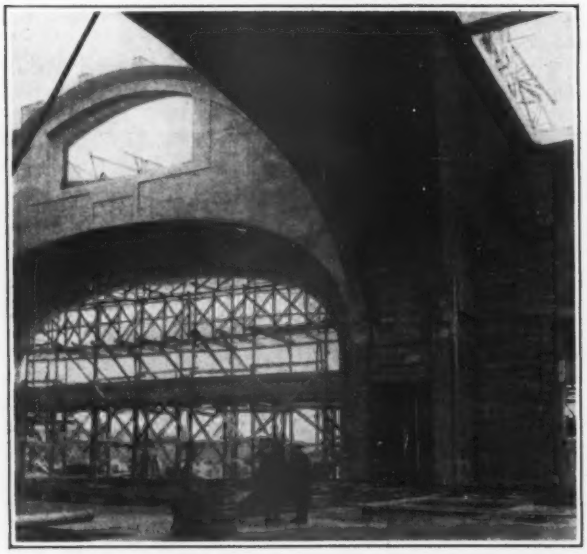


FIG. 4—ELLIPTICAL ARCHES DESIGNED AS BEAMS IN LIMOGES RAILWAY STATION

directly on the columns. The six-story building adjacent uses concrete floors throughout, and because of the difficulty of obtaining sufficient depth for the large stresses coming from the aisle in part *D* (Fig. 1), some floors are designed as plain slabs 1 ft. thick; all others are designed as T-beams.

The work was let by the Compagnie des Chemins de Fer d'Orléans to the Société des Grands Travaux, Marseille, France. The work was carried out by C. N. de Saint-Denis, superintendent for the contractor, and by the writer.

Relative Fertilizing Values of Wet and Dry Sewage Sludge

FIELD TESTS of the relative fertilizing value of liquid and air-dried sewage sludge carried on for three years at Bedford, England, show the "wet" sludge to be much superior to the "dry" in crop production, besides having other advantages. The wet sludge was run from the settling tanks into a special tank, thoroughly mixed, then discharged half to a drying bed and half to one of three test plots of agricultural land, the third being a control plot, receiving no fertilizer of any kind. After 28 days on the drying bed the sludge delivered there was taken to a drying shed, where the moisture was reduced to 28 per cent. As compared with the unfertilized or control plot, the area receiving liquid sludge yielded 110.5 per cent more crops in three years, whereas the plot receiving air-dried sludge produced only 59.06 per cent more.

Other advantages of the liquid sludge are: More even distribution and more even crop, improvement of the physical condition of the soil, including warming, mellowing and greater freedom of drainage. The foregoing statements have been taken from a paper presented in 1927 before the British Association of Sewage-Works Managers, by S. Duxbury, manager of the sewage-works of Bedford, England.

Mr. Duxbury states that the cost of disposing of 12,000 long or 13,440 short tons of 95 per cent sludge on 30 acres of land at Bedford is £207 (about $1,000) of which £75 is for rent (50s. per acre), £60 for two plowings, £62 for labor (£50 for tank sludge and £10 for digging sludge channels on the land) and £10 for tools. This works out at 4d. per long ton (about 6.25c. per short ton). Rental value of the 30 acres of land is given as £240, leaving a balance of £33 (about $160). No estimate of the net operating cost of air-dried sludge is given. The Bedford sludge flows to the land by gravity. Its moisture content is varied according to the distance the sludge has to flow. After the application of sludge the land is allowed to rest until the sludge is fairly dry, whereupon the land is plowed and harrowed.

Preferred Number System Announced

A table of preferred numbers informally approved by the American Engineering Standards Committee has been published and is available for distribution. The fundamental elements of the system lie in the proposal to arrange standard-size series for most common commodities so that each succeeding model in a series shall be larger than the preceding size by a fixed percentage. By this means it is believed that much economic loss involved in the haphazard and needlessly numerous gradations of size of many commodities can be eliminated. As an illustration of the manner of working of preferred numbers, a difference of $\frac{1}{4}$ in. in width would be important in a brush $\frac{1}{2}$ in. wide, whereas in a brush 5 in. wide a difference of $\frac{1}{4}$ in. would be hardly discernible. Instead of having $\frac{1}{4}$-in. increases throughout the whole range of sizes, therefore, sizes can be increased by a fixed percentage without eliminating any that are necessary, and at the same time the total number of sizes can be decreased. If after a trial the system is accepted by enough manufacturers, it will be finally adopted by the committee as one of its standards.

American Railway Engineers Meet in Chicago

Twenty-ninth Annual Convention of American Railway Engineering Association—An Unusually Active and Well-Attended Meeting—Minor Changes in Procedure Stimulate Discussion

WITH an attendance of 37 per cent of the entire membership of the association and a total registration of 1,316, including guests, the American Railway Engineering Association held its 29th annual convention at Chicago March 6-8. Morning and afternoon sessions were held each day for the presentation and discussion of committee reports, following the established custom of the association, and at no time were there less than 150 men on the floor of the convention hall, and at most times the room was well filled despite the fact that it was the largest room ever used by the association for that purpose. Tuesday evening was given over to motion pictures of the Mississippi flood and of the Baltimore & Ohio "Fair of the Iron Horse." On Thursday evening the association held its annual dinner, at which L. A. Downs, president of the Illinois Central Railroad and a past-president of the association, was the principal speaker.

Convention Procedure—The possibility of making some change in the convention procedure had been under consideration by the board of direction and by a special committee appointed to consider the subject during the year, but after a careful weighing of the pros and cons the board decided not to make any change other than to require that all committee reports be in the secretary's hands earlier than usual so that they could be sent to the members at least a month before the date of the meeting. Consequently, the convention proceeded along its usual lines. There was, however, a noticeable increase in discussion from the floor, a fact indicating that the earlier publication of reports had had the desired effect.

The president, D. J. Brumley, touched upon this subject in his address at the opening of the convention and stated that he believed that one reason for the lack of discussion was the quite general agreement of the members of the association with the committees as to matters presented in their reports, and that whenever in the past committees had presented reports with which the members were not in agreement there had been no lack of discussion.

An innovation put into effect this year by the board of direction was the preparation of tentative committee assignments in advance of the meeting rather than after it and their publication in the year book which was distributed at the opening of the first session. This action will permit the committees to get to work early this winter rather than in the late spring or summer as heretofore. The board also set the date for filing committee reports as Nov. 30, following out the recommendations of the special committee on convention procedure.

Manual of Recommended Practice—The subject of the revision of the manual of the association was reported upon by President Brumley and by Secretary E. H. Fritch in the latter's annual report. Mr. Brumley stated that the proposal made last year to the effect that revision of the manual should be placed in the hands of a group of full-time experts had been considered by the board of direction, but had been abandoned, chiefly because no experts could be found more familiar with each of the various subjects than were the committee members. Secretary Fritch reported that the new manual was largely set in type and would be published as soon as possible after the matter approved for inclusion in the manual at this year's convention could be put into shape for that purpose. The present manual was published in 1921.

Committee Reports

Reports from 24 standing and special committees were considered at the convention. A summarized review of the proceedings is given in the following report.

Rails and Transverse Fissures—One of the most important reports was that of the committee on rail, which included among other matter a description of the new car for detecting transverse fissures in rails in service in the track. This device was suggested by E. A. Sperry, and laboratory investigations a year ago were so successful that in August an agreement was made for the construction of a car for detecting and marking internal failures in rail heads. The apparatus is mounted on a four-wheel track car, which is hauled at about 10 m.p.h. by a motor section car. Preliminary trials are now being made on a main-line high-speed track. J. V. Neubert (New York Central), in discussing the value of the device, stated that it still is in the development stage and that as good results cannot yet be obtained on ordinary track as have been obtained in the laboratory.

Construction of the detector car was financed by the American Railway Association.

Rail failure statistics compiled by the committee show that the five-year record for rails rolled in 1921 is 98.9 failures per 100 track-miles. This is better than any since 1915, but it is expected that the 1922 rails will not quite equal this low record. On the other hand, the 27,346 failures in 1926 due to transverse fissures were 318 in excess of the 1925 record. An extended progress report on the battering of rail ends showed the value of heat-treated rails, the influence of mill practice and the relation of carbon content.

Track Structure—Although few railways use the exact ballast sections and specifications of the association, much of the practice of individual railroads is based on this information, according to the committee on ballast. As to determining the shrinkage of ballast, the report outlined the difficulties of comparing measurements made at the pit and in the track. Remedy and prevention of "pumping" rail joints was another subject included. The report of this committee was accepted without discussion.

On the basis of laboratory experiments, the committee on ties recommended for inclusion in the manual a statement that the diameter of holes bored for cut spikes should be $\frac{1}{16}$ in. and $\frac{1}{8}$ in. less than the width of spike, for hard and soft woods respectively, but the objections to it were so strong that that part of the report was referred back for further consideration.

Curve elevation produced considerable discussion, following a statement by the committee on track that revision of the manual in this respect is under consideration. Several speakers considered excessive super-elevation to be the main cause of trouble. R. B. Leffler (New York Central) said that a car moving on a curve is considered generally as a solid body, whereas it consists of upper and

lower parts separated by springs. The swaying of the body on the trucks sets up vertical reactions that may actually lift the wheels from the outer rail. It also produces severe lateral forces, both on curves and tangents. He thinks that the whole subject should be restudied in the light of present-day knowledge and conditions. Different cases of derailments were cited, and Louis Yager (Northern Pacific) referred to difficulties in determining the causes of serious derailments. W. H. Kirkbride (Southern Pacific) cautioned against writing theoretical rules for track elevation into the manual which would produce a dangerous condition if applied to track having both slow- and fast-moving traffic, stating that practical considerations always must govern.

Protection of track and steel structures from corrosion by brine dripping from refrigeration cars was another subject of discussion. Hunter McDonald (Nashville, Chattanooga & St. Louis) puts galvanized iron under the ties and sprays the track with crude oil of high asphalt content. W. H. Courtenay (Louisville & Nashville) and Mr. Leffler (New York Central) referred to the general failure of special paints and coatings. The general opinion was that the most effective remedy would be for the railroads to be more strict in refusing to handle cars not equipped to retain the brine drippings.

Mr. Courtenay presented a motion to the effect that the board of direction take up the matter with the American Railway Association, asking it to co-operate by enforcing the present rules providing for brine containers. R. H. Ford, speaking for the board of direction, stated that the board intended to extend its activities to removing the cause of the trouble now that it had information as to the serious effect of brine drippings on railway structures.

Records of tie renewals and of tests of piles for marine work were brought up to date in the report of the committee on wood preservation. A record of 815 ties treated with creosote-petroleum shows that the 19 per cent removed up to October, 1927, averaged a life of fourteen years.

A progress report of the committee on stresses in railroad track, presented by Prof. A. N. Talbot, outlined investigations as to the design and behavior of rail joints.

The subcommittee on permanent roadway reported that it hopes to have some definite cost figures for comparison of the expense of maintaining permanent track with that of ordinary track. An examination of the stretch of permanent track on the Pere Marquette by the committee indicated that it is giving satisfactory service. There has been no settlement and only a few hair cracks are noticeable in the concrete. There has been some trouble with insulation and some unevenness of the surface due to failure of the insulating pad. There also has been some trouble with the rail fastenings, the type of rail clips used having been found to be too light. The committee reported that there has been little trouble with batter of the rails due to lack of resiliency in such track, that smoothness of the rail seat appears to be the essential point in preventing batter. Arthur N. Talbot, in commenting on this latter point, stated that he thought a long time would elapse before we could form definite opinions on the amount of resiliency required in permanent track, that meanwhile we may find that we should have a quite different rail section for use on such track. Professor Talbot also is of the opinion that research should be undertaken to determine what reduced train resistance is to be obtained from the use of permanent track.

Stations and Freight Yards—Grades for station ramps, as now given in the manual, were changed, on recommendation of the committee on yards and terminals, to a maximum of 10 per cent for pedestrians and 7 per cent for trucking. For weighing cars in motion, also, the minimum time on the scale was increased from three seconds to four seconds. This report included the coordination of railway and motor coach terminal facilities and a study of widths of driveways in team yards and at freight houses to suit modern motor truck service. There was also presented the theoretical layout for a large gravity classification yard, designed independently of such local restrictions as property limits or topography, showing the several facilities required and their logical positions in relation to one another. Closely related to this subject was information presented by the committee on economics of railway operation as to flat and gravity switching. It indicated that the latter is justified for a yard handling 700 cars in and out daily, with fifteen classifications. This report also discussed motor trucks and bus lines as affecting railway operation.

Bridges and Buildings

A proposed revision of the matter on "punched and reamed work," now in the specifications for steel railway bridges, as printed in the manual was submitted as information by the committee on iron and steel structures, but no action was recommended. Specifications for steel highway bridges have been prepared in co-operation with the American Society of Civil Engineers and the Association of State Highway Engineers, but were not completed in time for presentation with the committee's report. In order to expedite matters it was voted to have these printed in the association's April bulletin as advance information, so that they may come up for discussion or action at the 1929 meeting.

As to copper-bearing steel, the report stated that it is now obtainable readily at a slight increase in cost, has been used in several important bridges and is being used increasingly for structural work, particularly in trusses for railway shops where corrosive influences have to be considered. But for railway bridges it has been used very little.

Specifications for timber piles, submitted by the committee on wooden bridges and trestles, were adopted for the manual. This report pointed out that the old rules for grading lumber are still being used, but that it is to the interests of the railways to have all material specified and purchased according to the new rules already adopted.

Specifications for foundation work, submitted as information by the committee on masonry, included open wells, dredged caissons, pneumatic caissons and floating caissons on piles. There was also tentative specifications for reinforced-concrete columns and flat-slab spans. On the basis of an inquiry, the committee considers that size of mixer has little or no relation to quality of concrete produced.

Formulas for flexure of reinforced-concrete T-beams were adopted for the manual. There was some discussion as to the respective merits of having cement furnished by the contractor and the railroad. H. C. Crowell (Pennsylvania) favored railroad supply, whereas M. Hirschthal (Delaware, Lackwanna & Western) favored supply by the contractor on the ground that the contractor could not then place the blame for poor concrete upon the cement furnished by the railroad company.

The lighting of railway stations, yards, shops, and offices was the main subject in the report of the committee on building, recommending different systems for different conditions. Tentative specifications for concrete, wood block, asphalt block and other materials for paving and floors were accepted as information after some criticism as to their prolixity and repetition and a tendency to include contract matter in specifications.

Railway Economics

A statement by the committee on economics of railway labor to the effect that very little information could be obtained as to the economic value of labor-saving devices brought considerable comment. Mr. Ford (Rock Island) thought this situation strange in view of the great development and use of machines for track work during the past ten years. He suggested that officials either are not sufficiently familiar with the machines they have in service or are not operating them in such a way as to produce real economy. On the other hand, Mr. Kirkbride (Southern Pacific) pointed out that many machines are still in the experimental stage, and Mr. McDonald (Nashville, Chattanooga & St. Louis) said that as the machines may be idle for much of the time it is difficult to determine the actual saving in cost of work.

W. C. Barrett (Lehigh Valley) said that extensive use of machines and appliances on his road has reduced the maintenance cost and that there is not much idle time. W. P. Wiltsee (Norfolk & Western) suggested that for roads with very heavy traffic it may be well to consider machines that can be used without occupying the track and thus be free from continual interruption of their work. In discussing the value of employing a permanent track force and distributing track work throughout the entire year, the committee remarked that the average railway officer needs to be educated as to the fact that maintenance-of-way work requires skilled men.

A comparison of grade reduction and more powerful locomotives as means of increasing train loads, supplemented by a statement as to the relation of electric locomotives to grade revision projects, was the main feature of the report of the committee on economics of railway location. In discussing the relation of the booster engine to the power capacity of locomotives, W. H. Winterrowd (Lima Locomotive Company) showed reduced cost of operation with greater loads and reduced cost of locomotive maintenance, both resulting from the easier starting due to the excess power available.

The importance of providing for intensive use of single track with heavy traffic, before undertaking the expense of a second track, was discussed by the committee on economics of railway operation. It was suggested by J. P. Hanley (Illinois Central) that the committee should consider the spacing of water stations in relation to improving train movements, that as this subject is being considered also by the committee on water service it should be handled jointly.

Grade Crossings and Signs

A modified form of the "cross-buck" highway-crossing sign was submitted for the manual by the committee on grade crossings, but after much discussion it was referred back to the committee. The main point of controversy was the addition of a board showing the number of tracks at the crossing. Arguments on both sides resulted in the vote for further consideration. The same fate attended designs for flashlight or highway signals.

As to the problem of the increasing number of new crossings, R. H. Ford (Rock Island Lines) said that railways are inclined to be too easy. The policy of the Rock Island Lines is to refuse permission for any new crossings and to inform the state authorities that they must assume all responsibility for ordering a new crossing. As a result about two-thirds of the applications are denied by state authorities. Furthermore, when questions of grade crossings or grade separations come up, the Rock Island sends its engineers to study the situation and report on some satisfactory solution.

This subject was included also in the report of the committee on signals and interlocking. In view of the number of devices proposed for grade-crossing protection and the number of organizations engaged in an effort at standardization, there is danger of great confusion. The committee suggested that it is the duty of members of the A.R.E.A. to advocate the use of standards of this association and the American Engineering Standards Committee, and to discourage any variations. A. H. Rudd (Pennsylvania) referred to the lack of uniformity in distributing the expense of crossing protection. In Pennsylvania the railroad pays half the first cost of automatic signals and of advance signals where the crossing signal cannot be seen at 500 ft. The operating and maintenance costs are borne by the railway for the signal and by the state highway department for the advance sign. He suggested that as it is the great increase in highway traffic that increases the danger of crossings, the cost of protection should reasonably be shared by the public. R. H. Ford (Rock Island) thought that a fair distribution of cost was more important than a uniform distribution. In a discussion as to traffic signals at street crossings, the committee accepted the suggestion that it is not advisable for the railroad to give any form of clear or "go" signal for the highway traffic.

Miscellaneous

Forms of agreements of interlocking plants, industry tracks and joint use of freight terminals, submitted by the committee on uniform general contract forms, were adopted for the manual. Difference of opinion developed over the recommendation to drop an agreement for use of railway property for public highways, as not being needed. The opposition, headed by R. H. Ford (Rock Island Lines) considered the subject of special and growing importance, and the committee finally withdrew its recommendation and consented to prepare the form.

In the discussion of a tentative form for cost-plus-percentage construction contracts, it was suggested that it should provide for all unused material to become the property of the contractor, who would be required to refund allowances made for it. This practice was recommended as a check on unnecessary purchases by the contractor.

A system for keeping property records up to date was submitted by the committee on records and accounts for inclusion in the manual, but this action was opposed and finally the matter was accepted simply as information. A voluminous review of revisions of the Interstate Commerce Commission classification of accounts was a conspicuous and valuable part of this committee's report.

A review of the use of the association's recommended practice was a specially interesting feature of the report of the committee on standardization; it indicated quite extensive use by railways in general either directly or as a basis for individual practice.

Engineering Literature

A Monthly Review of Books and a Listing of New Publications

Four Phases of Highway Materials

REVIEWED BY H. S. MATTIMORE

Engineer of Tests and Materials Investigation, Pennsylvania Highway Department, Harrisburg, Pa.

HIGHWAY MATERIALS: A Textbook Covering Production, Specifications, Sampling and Testing of Highway Materials—By Edward E. Bauer, B.S., C.E., Assoc.M.Am.Soc.C.E., M.Am.Conc. Inst., Instructor in Civil Engineering, University of Illinois. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. 353; halftones and line cuts. $3.50.

Production, specifications, sampling and testing of highway materials are treated in this book.

Part I deals with the production of bituminous materials, cement, mineral aggregates, paving brick and wood block and the standard specifications for the main materials used in highway surfacing courses. It is brought up to date in commenting briefly and giving test results on special early hardening cements. The several summary tables of the American Society for Testing Materials specifications are a valuable compilation for a book of this kind. The brief notes discussing the value of some of the tests are an aid to the student as well as to highway construction engineers. This procedure could be elaborated upon to the value of the publication, especially for practicing engineers.

In Part II examples are given of typical specifications used for construction. This is an excellent feature and of considerable value to the highway engineering student. The specifications are well selected, as they are ones which have been used for the control of the construction of a large mileage of pavement. The discussion of qualities of materials and the brief description of some construction methods are worthy of favorable comment. The author shows familiarity with the latest practice, and at the same time has so chosen features for comment as to avoid controversial methods. The discussion of expansion joint and surface treatment materials and specifications includes late practices in many state highway departments. This part of the book covers a field that is comparatively new in publications on highway materials. It is a transition stage from technical material testing and standard specifications toward construction and use of materials without actually invading construction details. This should be of value to the student in acquiring knowledge of how theory is applied, and to the construction engineer in appreciating the value of a knowledge of general material qualities.

Part III contains a brief discussion of the necessity for proper sampling of materials and gives the standard methods for sampling the main materials used in highway construction. The sampling of materials for tests is such an important operation that a fuller discussion of its importance and amplification of the standards would be a valuable addition to this part of the book.

Methods of tests for highway materials are presented in Part IV. The methods given are mainly standards of the American Society for Testing Materials and of the American Association of State Highway Officials, as published in United States Department of Agriculture Bulletin 1216. The sequence of the different tests is well arranged, and the author's comments relative to the care to be observed in the various steps show an excellent detail knowledge of the subject.

The statement accompanying the title of the book, "a sound treatment of the production, specifications, sampling and testing of highway materials," is well justified by the text. The book can be recommended as a good text for engineering classes and a valuable assistance to a highway construction engineer who desires to obtain a good working knowledge of highway materials.

Is Federal Reclamation a Failure?

REVIEWED BY M. R. LEWIS

Head, Depart[illegible] of Agricultural Engineering, University of Idaho, Moscow, Idaho

THE ECONOMICS OF LAND RECLAMATION IN THE UNITED STATES—By Ray P. Teele, Agricultural Economist. Chicago, New York and London: A. W. Shaw Co. Cloth; 6x9 in.; pp. 337; 13 line cuts. $4.

The late Mr. Teele's book contains a great wealth of data gathered by him during his many years' study of irrigation. Much of this information is of value in carrying on an economic study of the reclamation of land. Some of it is chiefly of historical value. The data are largely from such accurate and impartial sources as the United States Census and reports of the United States Departments of the Interior and of Agriculture. The interpretation of these data, however, seems to be somewhat affected by the author's previously formed opinion against the economic feasibility of reclamation by irrigation and drainage.

A few examples will illustrate this point. On p. 14 the following statement is made: "Probably it is safe to say that, in the case of a large majority of irrigation projects, the farmers eventually got control of their irrigation works for much less than they cost." On p. 131 data from the 1920 Census are represented as showing that in 1919 "individual and partnership enterprises [supplied] 36 per cent, co-operative enterprises 34 per cent, Carey act enterprises 3 per cent, irrigation districts 9 per cent and government enterprises 7 per cent" of the irrigated area while "the remainder is supplied by commercial enterprises . . . cities and by the United States Indian Service." The individual and partnership enterprises were constructed by the farmers themselves and the farmers do not yet control those constructed by the commercial enterprises, cities and United States Indian Service. Many of the co-operative enterprises also were constructed by the farmers themselves and certainly an occasional project has been a paying proposition for outside capitalists. The "large majority" must then irrigate considerably less than 53 per cent of the area.

In Table 18, under the Boise project, the "irrigable acreage given includes the area for which a supplemental supply is furnished by the government works, while the "irrigated" area does not include these lands. When this correction is made, the Boise project will be found in the list of projects having more than 75 per cent of its irrigable area irrigated in 1924.

In the discussion of the returns from irrigation (p. 235) a comparison is made of the gross returns from non-irrigated lands with the corresponding returns from

irrigated land after the annual cost for irrigation has been subtracted. The amount subtracted is $10.50 per acre, which "includes a payment on the principal" (p. 225). There is no more reason for subtracting this payment on the principal than there would be for subtracting an installment payment on the price of the land itself. It is interesting to note that even on this basis the figures show that on the average irrigation farming pays a little more than average non-irrigation farming.

In spite of these rather obvious cases of depreciation of reclamation the book contains many ideas that are worthy of more general consideration. There can be no question that the real security behind loans on agricultural lands, not only those reclaimed by more or less public agencies but also all other farm lands, is the earning power of the farms. The experience of banks and other agencies that loaned money to farmers all over the country on the basis of war-time prices has demonstrated this. In view of this rule, the fact that the value of the raw land on one of the new projects is only 3 per cent of the cost of the proposed water supply is of no consequence (p. 173). Bare land that is practically useless is no security for a loan. The real security is in the earning power of the land with water.

This brings up the point chiefly stressed by Mr. Teele, and properly so, the fact that "the fundamental reason for the financial failure of irrigation enterprises has been the lag between expenditures for construction and the utilization of the land for which water has been provided" (p. 181). This lag has in fact been responsible for more troubles in land reclamation than all other causes combined.

The chapter on water rights is particularly good, although it does not have any very direct bearing on the economic problem. The emphasis on the lack of documentary evidence as to the value of specific water rights is worthy of attention.

It is unfortunate that the impression to be gained from reading this book is that land reclamation, and especially federal reclamation, has been a complete failure. Everyone conversant with recent agricultural conditions knows that all classes of farm lands have been a drug on the market for several years. The rural and even the general press have been full of stories of the abandonment of farm lands in the humid sections of the country. Actually little irrigated land has been abandoned so far as the present writer's experience in the Northwest goes.

There is still opportunity for an impartial study of land reclamation economics. Mr. Teele's book furnishes many valuable data and leads toward the discovery of many more data for such a study.

On Using Aerial Photographs

AERIAL PHOTOGRAPHS: Characteristics and Military Applications—By Dache M. Reeves, First Lieutenant, Air Corps, U. S. Army; formerly Instructor in Aerial Photography, Air Corps Advanced Flying School. [Ronald Aeronautical Library, C. deF. Chandler, Editor.] New York: The Ronald Press Co. Cloth; 6x9 in.; pp. 307; 123 illustrations, mostly halftones. $5.

With the growth of popular interest in aeronautics and the ever-increasing use of aerial mapping, this volume, which sets forth the first principles of reading and applying aerial photographs, is timely. Though the book, divided into two parts, treats of the characteristics of aerial photographs, the larger part of the volume concerns itself with the military features of aerial photography. The first part explains by means of descriptions and examples the character of photographic features and the technique of recognizing objects. No attempt is made to cover the subject exhaustively. However, the instructions which are given relating to methods of mapping are comprehensive. Though some consideration is given the applicability of air photography to topographic work, the book devotes itself more exhaustively to the development among a greater number of people of a "terrain sense."

Modern Highway Construction

REVIEWED BY HAROLD M. LEWIS
Executive Engineer, Regional Plan of New York and Its Environs, New York City

DER NEUZEITLICHE STRASSENBAU: Aufgaben und Technik—Von E. Neumann, Dr.-Ing. Dr. Ing. e. Professor an der Technischen Hochschule zu Stuttgart. (II Teil, Eisenbahnwessen und Städtebau, 10 Band, Handbibliothek für Bauingénieure, Ein Hand- und Nachschlagebuch für Studium und Praxis—Herausgegeben von Robert Otzen, Ghr. Regierungsrat, Professor an der Technischen Hochschule zu Hannover.) Berlin: Julius Springer. Cloth; 7x10 in.; pp. 400; 210 line cuts and halftones. Cloth, 29.5 reichsmarks, in Germany.

Professor Neumann's book on modern highway construction is one of a series of 27 volumes, in German, of a reference library for public-works engineers, edited by Prof. Robert Otzen of Hanover. The work was prepared in the belief that the relatively recent problems presented by the modern motor vehicle require a new book for the guidance of highway engineers. The author has, therefore, attempted to deal comprehensively with both the problems and the science of highway construction and has been very successful in covering the field. The present-day demands and needs of street construction in Germany are stressed, but there are many references to the methods and results employed in other countries, particularly in America. The volume is freely illustrated and contains diagrams and tables that would be of use to either the designing or the construction engineer.

It is pointed out that the streets over which modern vehicles move must approach the character of a railroad right-of-way. The problem is more complicated than the railway problem because of the varied ownership of parts of the street system and the lack of direct cooperation between the street owner and the street user. It is necessary to know more about the dynamic forces that take place in connection with street traffic and to use such data to a greater extent in the design of our streets. For this reason the author, after a brief description of such trends in street construction, describes in considerable detail the various types of motor vehicles and the growth in registration in different countries. Registration in 1926 ranged from one vehicle for every six persons in the United States to one for every 346 in Italy. In Germany the ratio was one to 211.

Next the author takes up, in considerable detail, the construction and operation of motor vehicles and the stresses resulting in both the vehicles and the roadway surfaces. In connection with the latter, the types of machinery used are described and the results obtained are given in tables and diagrams.

The fourth chapter (42 pp.) covers the various problems connected with the street plan, including alignment, grades, operation costs of vehicles, and tractive resistance. Data are given concerning the space requirement for various types of traffic. The need of the separation of grades, both at railroad intersections and at crossings with important traffic streets, is stressed. As examples of the latter, reference is made to the super-highways planned by the city of Detroit and to

the Park Avenue viaducts already built around the Grand Central Terminal in New York City.

Almost half of the book is devoted to a chapter on the various types of pavement construction, including foundations, drainage, grading, composition of paving materials and the methods of construction and design for various types of street surface. About 50 pp. of this section relate to concrete paving. It is pointed out that concrete pavement has, up to this time, been used to only a small extent in Germany. Roadway widths and typical subdivisions of streets into roadways, walks, etc., are discussed in two short chapters. These are freely illustrated by examples from typical streets in different countries. An interesting suggestion is the utilization of wide parked streets for the separation of residential and industrial sections of the city. The illustration given shows a central park area of about 100 ft. in width with a narrow residential street on one side and a wider industrial street on the opposite side.

Considerable space is given to the testing of street construction materials, describing both the machinery used for this purpose and the standards which should be met. The chapter on the economics and costs of street pavement gives interesting and useful data for different types of street surface and under various traffic conditions. The machinery used in the street construction and maintenance is described and freely illustrated in a separate chapter. Shorter chapters take up such questions as traffic capacities, traffic regulation, special motor express highways and experimental pavements.

Our Higher Educational Institutions

AMERICAN UNIVERSITIES AND COLLEGES—Edited by David Allan Robertson. (The American Council on Education). New York and London: Charles Scribner's Sons. Cloth; 6x9 in.; pp. 884. $2.50.

The character, scope and organization of higher education in the United States are reviewed in Part I of this volume. Part II presents condensed information regarding each of the universities and colleges on the accredited list of the American Council of Education. Supplementary information regarding thirteen classes of professional and fifteen classes of graduate schools is given in Part I. For some unexplained reason, engineering schools have far less space in proportion to their number than the other schools. Thus 130 engineering schools receive less than three pages, consisting mostly of names of schools by states, whereas 25 schools of economics have eleven pages, with a list of professors, their degrees (by institutions), the subjects they teach, and, in some instances, other information as well.

The great variety of college degrees granted in America is illustrated by a list of the corresponding abbreviations used in the book, which has about 170 entries, of which 40 are courses in engineering, not including B.S. in Geodesy and Surveying or San.D for Doctor of Sanitation. Another item of interest gleaned from the book is the hospitality shown to students from abroad by our schools and colleges. Figures for the year 1923-24 compiled by the Institute of International Education for only 400 institutions showed 6,988 foreign students. Deducting 1,332 as "unclassified," it appears that more than one-fifth (1,238) of the remaining 5,656 were students in engineering, compared with 1,966 students in liberal arts, 510 in medicine and 389 in commerce. The total number of students from more than a hundred foreign countries is given for the five college years ended with 1925-26. The five countries highest in number of foreign students in American colleges for the year 1925-26 were: China, 1,317; Canada, 733; Japan, 685; Poland, 571; Russia, 515. Totals for each year are not given.

It is a great pity that after bringing together so many figures on a variety of subjects as this volume contains, practically no summaries are included. Another sad lack of the volume is an introduction in the nature of a general summary. Valuable as the book is as a compilation, it is chiefly that and nothing more. Certainly a book sponsored by educators should supply digests of the data it contains instead of compelling thousands of users to make the digests separately or do without them.

For Laymen, Including Engineers

ARCHITECTURE EXPLAINED — By Howard Robertson, F.R.I.B.A., S.A.D.G., Principal, Architectural Association School of Architecture, Author of "The Principles of Architectural Composition," etc. New York: The George H. Doran Co. Cloth; 5x8 in.; pp. 212; frontispiece and 24 insert halftones. $2.50.

Engineers whose ideas of architecture are so hazy that they are willing to be classed with the "laymen" for whom this book is intended could read it with personal pleasure and professional profit. This is particularly true of structural engineers who today are designing practically all the bridges and a large percentage of the buildings into which competent design enters.

Although the book as a whole justifies its title, Architecture Explained, the author does not present a clear cut definition of what architecture is. In his introductory chapter he conveys the idea that design is what constitutes architecture. A few sentences, or phrases, or even an adjective or two would have made clear the conception of architecture held up throughout the book: The design of structures to suit their function and at the same time give esthetic pleasure to those who see them—at the least through the fitting of form to function; at the most, by the aid of some one or many things not essential to function, which may go all the way from accent to ornamentation. After the introductory pages the reader is carried through the main periods of architecture and shown how each became the expression of the life and spirit of the time and people where it flourished—and, ceasing to do, fell into decay, generally with more or less successful "revivals" centuries afterward. Next there are chapters on design, character and styles. Then modern architecture in England, America and Europe are taken up and finally architecture of the future. In the latter the author says:

> Future progress will demand much closer co-operation between the architect and the technical engineering specialist. . . . The engineer undoubtedly has the capacity to overcome structural difficulties and co-operate with the manufacturer in developing the possibilities of new materials, but . . . the architect must step in and through his knowledge of design and resource of invention indicate the lines along which research can most profitably be made. At present, unfortunately, the architect is so often busily engaged with researches into the past that the possibilities of the future, and even the present, are neglected, and no experimental department or information bureau for the examination of new methods exists within the profession, so that organized liaison with the engineer and the builder on purely technical matter can scarcely be said to exist.

Admirable halftones illustrate many of the points made by the author. A brief bibliography enables the reader to pursue the subject further. References to

American architects and architecture are quite frequent and favorable. The book is informative and suggestive and might well be read by engineers in conjunction with The Architect in History, noticed in these columns for Nov. 17, 1927, p. 806.

Public Parks From a French Viewpoint

PLANTATIONS, PARCS ET JARDINS PUBLICS—By Georges Lefebvre, Ingénieur des Ponts et Chaussés en Retraite Conservateur Honoraire des Promenades de la Ville de Paris. (Bibliotheque de L'Ingenieur de Travaux Publics.) Deuxième Edition. Paris: Dunod. Paper; 5x7 in.; pp. 376; halftones and line cuts.

This volume is rather unusual in that it contains exhaustive information on the maintenance of public parks. The first part takes up the choice and placing of trees and shrubs, actual work of planting, maintenance of planted areas, how to identify and treat floral diseases, besides giving statistical information. The second part, concerned with walks, parks and public gardens, treats exhaustively of design and maintenance. The volume is profusely illustrated and should prove a valuable addition to the library of landscape architects and engineers and park superintendents.

Publications Received

DATA AMASSED in a geodetic survey of Columbus, Ohio, now completed, and in a topographical survey now under way are included in an illustrated pamphlet report obtainable from either the City Planning Commission, Columbus, Ohio, or R. H. Randall & Company, Inc., Toledo, Ohio.

PUBLIC HEALTH LAWS of North Dakota and the rules and regulations of the State Department of Health made in accordance therewith fill a 91-p. pamphlet which may be obtained from Dr. A. A. Whittemore, State Health Officer, Bismarck, N. D.

ENGINEERS, ARCHITECTS AND BUILDERS will find much information in Physical Properties of the Principal Commercial Limestones Used for Building Construction in the United States, by D. W. Kessler and W. H. Fligh, research associate and associate physicist, U. S. Bureau of Standards. (30c. from Superintendent of Documents, Washington, D. C.)

THE GROWING IMPORTANCE of what is concisely expressed by water and sewage chemists as the B.O.D. has led to the publication of Public Health Bulletin 173, The Oxygen Demand of Polluted Waters, by Chemist Emery J. Theriault, U. S. Public Health Service. The pamphlet of 185 pp. contains a brief preface by Prof. Earle B. Phelps. Most of the contents of the bulletin are highly technical, but that does not lessen the value of the publication for those for whom it is intended.

A COMPREHENSIVE REVIEW of a subject of broad general interest, with the title, The Administration of the Gasoline Tax in the United States, has been made by F. G. Crawford, professor of political science, Syracuse University. Compressed into 28 pp. are many data on the gasoline tax as now levied by 46 of the 48 states of the Union. The tabular data are discussed with interpretative comment. There is a section on the constitutionality of the tax. (55c. from Municipal Administration Service, 261 Broadway, New York City.)

COST RECORDS ON TRACK WORK is the subject of a lengthy report by G. H. R. Howe, cost engineer of the Chesapeake & Ohio Railway, in the "Proceedings" of the Roadmasters and Maintenance of Way Association. Classification of track work is given, with forms for records and instructions as to reporting and distributing the time charges. Examples of records are given, and the report is supplemented by several pages of discussion. $1, from T. F. Donahoe, secretary, 428 Mansion St., Pittsburgh, Pa.)

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

WIDENING AND SUPERELEVATING OF ROADWAY CURVES: A Field Book for Highway Engineers—By John H. Fletcher, C. E. Topeka, Kan.: John H. Fletcher, P. O. Box 231. Cloth; 3x4½ in.; pp. 63; 8 linecuts; 24 tables. $2.50.

STEEL CONSTRUCTION—By Lee H. Miller, Chief Engineer American Institute of Steel Construction. Cloth; 5x8 in.; pp. 384; $1.50 from American Institute of Steel Construction, 285 Madison Ave., New York City.

FREDERICK LAW OLMSTED: LANDSCAPE ARCHITECT, 1822-1903—Edited by Frederick Law Olmsted, Jr., and Theodora Kimball. Vol. II. Central Park as a Work of Art and as a Great Municipal Enterprise, 1853-1895. [Forty Years of Landscape Architecture, Being the Professional Papers of Frederick Law Olmsted, Senior.] New York and London: G. P. Putnam's Sons. Cloth; 6x9 in.; pp. 575; 30 illustrations. $7.50.

FEDERAL AID: A Study of the American Subsidy System—By Arthur F. Macdonald, Ph.D., Assistant Professor of Political Science, University of Pennsylvania. New York: Thomas Y. Crowell Co. Cloth; 6x9 in.; pp. 285. $2.75.

THE LAW OF SPECIAL ASSESSMENTS IN MINNESOTA—By Harold F. Kumm, LL.B., S.J.D. Minneapolis, Minn.: League of Minnesota Municipalities (University of Minnesota Library). Cloth; 6x9 in.; pp. 187. $2.

A digest of (1) constitutional provisions and court decisions, and (2) statutes, the latter confined to cities of the third and fourth classes and to villages. Covers all cities except Minneapolis, St. Paul, Duluth and Winona; the latter is a second-class city.

DEVELOPMENT OF THE UPPER SACRAMENTO RIVER—By Paul Bailey. Appendix to the Summary Report, 1927, on the Water Resources of California and a Co-ordinated Plan for Their Development. Containing Co-operative Report with U. S. Bureau of Reclamation on Iron Canyon Project, by Walker R. Young. Paper; 6x9 in.; pp. 209; illustrated. Sacramento, Calif.: Department of Public Works.

One of a series of reports begun in 1921 and carried on with legislative appropriations and funds from other sources that have totaled $440,000 to date. Although dealing comprehensively with the upper Sacramento River region, the bulletin devotes special attention to the problem of finding the best major project for developing storage.

INSTRUCTIONS FOR TIDE OBSERVATIONS—By G. T. Rude, Hydrographic and Geodetic Engineer. U. S. Coast and Geodetic Survey. Cloth; 5x8 in.; illustrated. 20c. from Superintendent of Documents, Washington, D. C.

UNIFORM BUILDING CODE—Prepared by Pacific Coast Building Officials Conference, and Adopted [by it] October, 1927. Paper; 6x8 in.; pp. 256. $1 from the organization named above, 19 Pine Ave., Long Beach, Calif.

EFFECT OF CLIMATIC CHANGES UPON A MULTIPLE-SPAN Reinforced Concrete Arch Bridge. By Wilbur M. Wilson, Research Professor of Structural Engineering, University of Illinois. Paper; 6x9 in.; pp. 65; diagrams. 40c. from Engineering Experiment Station, Urbana, Ill.; limited number free on application.

"Constitutes a part of the program of the Committee on Concrete and Reinforced-Concrete Arches of the American Society of Civil Engineers." Most of the work was done by staff members of the Illinois Experiment Station.

ENGLISH FOR ENGINEERS—By S. A. Harbarger, Assistant Professor of English, Ohio. Second Edition. State University. New York and London: McGraw-Hill Book Co. Cloth; 6x8 in.; pp. 300. $2.

The first edition was favorably noticed in these columns for Oct. 18, 1923, p. 648. In this edition the illustrative material and the suggestions for collateral reading have been extended.

MECHANICAL DRAFTING HANDBOOK: Standards, Conventions and Methods—By Frank R. Kepler, Supervisor of Industrial Arts, Department of Vocational Education, Detroit Public Schools. Milwaukee, Wis.: The Bruce Publishing Co. Stiff paper, cloth back; 6x9 in.; pp. 126; illustrated. 60c.

FAILURE OF A MATERIAL COMPOSED OF NON-ISOTROPIC ELEMENTS: An Analytical Study with Special Application to Concrete—By Anton Brandtzaeg. (Det Kgl Norske Videnskabers Selskabs Skrifter 1927. Nr. 2). Trondhjem, Norway: I Kommission Hos F. Bruns Bokhandel. Paper; 6x9 in.; pp. 68; 15 line cuts.

A summary (in English) of "an analytical study of the process of failure of a material, the constituent parts of which were assumed to be typically non-isotropic." The study was preliminary to a series of tests made by the author as a graduate student at the University of Illinois, under a fellowship granted by the Norwegian Institute of Technology, Trondhjem, Norway. Some notes on the tests are included in the reprint from the Norwegian publication named above. It is expected that the tests will be the subject of a bulletin issued by the Engineering Experiment Station of the University of Illinois.

THE MANUAL OF INDUSTRIAL SAFETY—By Sidney J. Williams, Director Public Safety Division and formerly Chief Engineer, National Safety Council; Chief Engineer, Wisconsin Industrial Commission. Chicago and New York: A. W. Shaw Co. Cloth; 6x8 in.; pp. 197; illustrated. $2.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Railway Meeting in Chicago Continues Its Annual Growth

Attendance Increases—More Live Discussions—Economic Studies Reported—Railway Show

RECORDS of attendance were broken for the third consecutive year at the annual meeting of the American Railway Engineering Association, held in Chicago on March 6 to 8. There were registered 968 members and 348 guests, making a total of 1,316, as compared with 1,271 in 1927 and 1,030 in 1926. The proceedings also included much more discussion than has been the case for the past few years. All the committees except one had their reports printed well in advance of the meeting, and that committee made a verbal report of progress.

In his presidential address, D. H. Brumley, chief engineer of Chicago Terminal Improvements, Illinois Central Railroad, referred to the important development of a device for detecting the presence and location of transverse fissures in rails, noted in the report of the rail committee in the summary of the convention proceedings on p. 449 of this issue. He noted also the approaching end of the primary stage of the federal valuation of railways, as tentative valuations have been served on all the roads and hearings on the protests are expected to be completed early next year. It is assumed, further, that the work of bringing the valuations up to date can be completed by 1931 at a cost of $7,500,000 to the U. S. government, after which time a current valuation can be maintained for an annual cost of about $500,000. As to railway work of the future, Mr. Brumley said:

"The need for new lines and extensions is almost satisfied and the work for the immediate future will be the orderly development of existing lines. The railways are susceptible of great improvements, such as reduction of grades and curvature, multiple tracking, diversion lines around congested centers, shortening of lines and the more extensive use of block signals. Where property values are high, double decking (and probably triple decking) of railway facilities may be economical, but such improvements will be quite costly and will not be undertaken unless they can be estimated to show resultant economy. Electrification will be extended, since it has great operating advantages under special conditions, such as density of traffic, heavy grades, feasibility of operation in congested terminals, a commutation service where frequent stops are made, and operation under covered areas where air-right developments are justified."

A total membership of 2,607, representing a net increase of 96 over 1927, was shown in the report of the secretary, while the treasurer's report showed a balance of $54,000, a net increase of $262.

The president elected for 1928 is W. D. Faucette, chief engineer of the Seaboard Air Line and formerly first vice-president of the association. Louis Yager, assistant chief engineer of the

(Continued on p. 467)

St. Francis Dam of Los Angeles Water-Supply System Fails Under Full Head

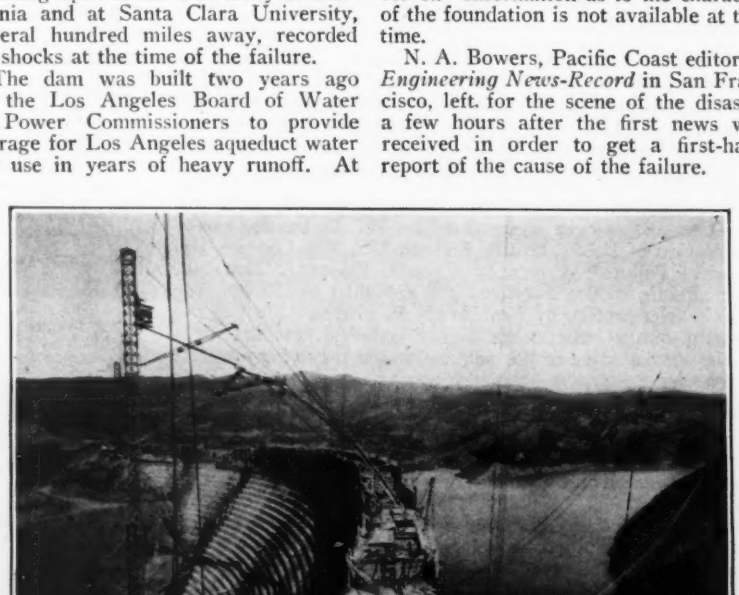
Central Section of Arched Gravity Dam Left Standing—Cause of Failure Not Yet Determined, But Seepage Under Dam Reported

THE St. Francis Dam of Los Angeles water-supply system, a concrete arched gravity structure 205 ft. high and 650 ft. long, located in San Francisquito Canyon above Saugus, Calif., failed shortly after midnight on the morning of March 13. The cause of failure has not been determined at the time this report was written (March 14). Residents near the dam state that seepage around and under one abutment had been noticed for some days. Early reports that the rupture was caused by an earthquake have not been confirmed. Seismographs at the University of California and at Santa Clara University, several hundred miles away, recorded no shocks at the time of the failure.

The dam was built two years ago by the Los Angeles Board of Water & Power Commissioners to provide storage for Los Angeles aqueduct water for use in years of heavy runoff. At the time of failure the reservoir contained its full capacity of 38,000 acre-ft. The indications are that failure occurred suddenly, the released water rushing down the canyon sweeping away ranch houses and two construction camps where more than 100 men are reported to have been sleeping.

Construction of the dam was completed in the spring of 1926. It is, as noted above, of gravity section arched on a radius of 500 ft. The maximum height of 205 ft. includes 30 ft. below the stream bed. The base thickness is 169 ft. Information as to the character of the foundation is not available at this time.

N. A. Bowers, Pacific Coast editor of *Engineering News-Record* in San Francisco, left for the scene of the disaster a few hours after the first news was received in order to get a first-hand report of the cause of the failure.



ILL-FATED ST. FRANCIS DAM—UNDER CONSTRUCTION, 1926

Faucette Elected President of Railway Engineers

William D. Faucette, chief engineer of the Seaboard Air Line Railway Company, was elected president of the American Railway Engineering Association at its annual convention held in Chicago last week. William D. Faucette was born at Halifax, N. C., June 27, 1881, and graduated with the degree of Bachelor of Engineering from the Agricultural and Mechanical College of North Carolina in 1901. He received the degree of civil engineer from the same college in 1910. Mr. Faucette began work with the Seaboard Air Line as an inspector in the engineering department on dredging and terminal work at Savannah, Ga., in 1901, and the following year was appointed assistant engineer on general construction and track work. From 1904 to 1906 he was an assistant engineer in charge of the assistant engineer's office at Savannah, and from 1906 to 1910 held a similar position in the chief engineer's office at Portsmouth, Va., assisting in the supervision of the office and general direction of the field work, including the bridge department and right-of-way office. In 1910 Mr. Faucette came to New York to become chief clerk to the new president, W. J. Harahan, formerly vice-president and chief engineer of the Erie Railroad, which position he held until in 1913 he was appointed chief engineer of the Seaboard Air Line.

Mr. Faucette has been active in the work of the American Railway Engineering Association since he became a member, having served as a vice-president for two years and as chairman of the committee on uniform general contract forms for some years before that.

Gasoline Tax Killed in Illinois

The Illinois 2c. tax on gasoline used by highway motor vehicles, which went into effect in August, 1927, has been wiped out by a decision of the state Supreme Court which holds that the tax was discriminatory and that the law was defective in various respects. The law did not apply to farm machinery, did not cover kerosene and left electric vehicles free from taxation. The money thus raised was to be used for road construction, and part of it was to be returned to the counties in proportion to their tax collections; therefore as a result of the decision both state and county road programs must be curtailed. In particular, the local road systems will suffer, since several counties had based large programs on the funds expected from this gas tax. Estimates by state officials put the amount already collected at about $8,750,000. Automobile interests and some large consumers have planned to secure refunds, but this would involve lengthy litigation and the outcome as to this proposition and as to the ultimate disposal of the tax fund is uncertain.

National Hydraulic Laboratory Opposed by War Department

A recent proposal to establish a national hydraulic laboratory does not meet with the approval of the Secretary of War, who has been informed by the Chief of Engineers that measurements and observations on our largest rivers supply the best hydraulic data on the flow of such streams, since actual experiments with full-sized structures are preferable to experiments with small-scale models. Laboratory experiments, it is felt, are likely to lead to erroneous conclusions. According to reports from the War Department, the Secretary of War feels that studies and experiments pertaining to river and harbor and flood-control works should be under the direction of the authorities that are charged by law with planning and executing those works.

Railway Meeting

(Continued from p. 456)

Northern Pacific Railway, second vice-president, automatically becomes first vice-president. G. D. Brooke, general manager of the Chesapeake & Ohio Railway, was elected to succeed Mr. Yager as second vice-president. E. H. Fritch was re-elected secretary and F. J. Stimson treasurer.

Railway Equipment Exhibit

Equipment used in railway maintenance and signaling again made up the major part of the annual exhibit of the National Railway Appliances Association held at the Coliseum during the week in which the American Railway Engineering Association was in session at the Palmer House and the Signal Section of the American Railway Association was in session at the Stevens Hotel. Further increases in power-driven equipment for saving labor in trackwork, as noted in previous years, were in evidence this year. Four concerns were exhibiting pneumatic equipment for trackwork where three were exhibiting last year. It is interesting to note that the additional exhibit was by a German concern.

The amount of entirely new or novel equipment on display was not large, but there were a great many exhibits of improvements upon older types of equipment or modifications to meet present-day requirements. The latter is especially true of frogs, switches and track fastenings.

New officers of the National Railway Appliances Association are as follows: A. L. Greenabaum, vice-president of the O. F. Jordan Company, president; S. P. McGough, Lorain Steel Company, vice-president; and C. W. Kelly, secretary-treasurer.

Complete Deep Cofferdam Work on Hudson River Bridge

Last week the north cofferdam of the pair of piers forming the west tower foundation of the 3,500-ft. Hudson River suspension bridge at New York City was concreted, ending the last stage of difficulty in the enterprise. Sealing the bottom was completed at 11 p.m. on March 8.

The two cofferdams are about 100 ft. square, and at their outshore sides are 70 to 75 ft. deep to rock. The north cofferdam was the deeper and more difficult of the two. It was emptied of water finally on Jan. 25, and since that time the mud and boulders overlying the rock have been removed, the soft and unsound rock excavated, and the foundation concrete placed progressively, starting at the inshore and shallower side and working toward the deep east wall. The last concrete placed was in the extreme northeast corner and the deepest portion of the excavation was here 75 ft. below high tide. The placing of this concrete made a success of one of the largest sheet-pile cofferdams (and by far the deepest) ever attempted.

At the time of going to press, the entire pier, 89x98 ft. in plan, has been brought to an elevation of 25 ft. below tide, and the water has been allowed to rise between the pier shaft and the sheet piling.

The south cofferdam was completed about two months ago.

The rock finally reached in both cofferdams upon which the piers are founded is a firm white sandstone with bedding planes inclined toward the Palisades and away from the river gorge, thus forming a most satisfactory foundation for the giant towers.

The Silas Mason Company is the contractor for these piers, with Francis Donaldson as engineer. The work is being done for the Port of New York Authority. Details of the proposed bridge were given in our issue of Aug. 11, 1927, p. 212.

Lake States Sanitary Officials Reach Agreement on Pollution

Commissioners of the boards of health of the eight states bordering on the Great Lakes on March 8 entered into an agreement to further the elimination of pollution because of the recognized interdependence and necessity of the lakes as sources of water supply. Unless pollution is curbed in the future the waters will become so contaminated as to be impractical as sources of water supply. Dr. W. F. King, elected president of the organization of the officials, stated that it is proposed to follow along the lines found successful by the states along the Ohio River with their interstate stream pollution agreement.

At an early meeting the engineers of the various boards of health will be officially appointed to handle the engineering features. Dr. I. D. Rawlins, director, Illinois State Board of Health, was elected secretary.

New York State Architect

A statement not in accordance with facts later brought out was made in these pages Feb. 16, with regard to filling the office of New York state architect. The statement said, "Designated acting state architects since have been Joseph W. Sinnott, Walter G. Thomas and Walter C. Longleway. All refused to accept the office." The following is in accordance with facts now available: Mr. Sinnott, upon automatically becoming acting state architect, resigned. Mr. Thomas accepted the position and later resigned. Mr. Longleway accepted the position but was later promoted to the position of executive deputy state architect when W. E. Haugaard accepted the position of state architect.

Washington Notes

Flood Control; Utility Investigation; Public Contract Work; Columbia Basin

By Paul Wooton
Washington Correspondent

PROSPECTS favor consideration by the Senate of flood-control legislation in the near future. The steering committee has given it a preferred place on the legislative program. The Jones bill is certain to meet with strong opposition on the floor of the Senate. It is not satisfactory to the tributary interests. It is being fought by those who are anxious to grant no authority at this time for the construction of the floodways at Bird's Point in Missouri and in northeastern Louisiana and by those who would limit the additional water sent down the Atchafalaya.

The President's Commission

The economic commission proposed by the President to study the subject of local contributions is to consist of one appointee each of the secretaries of the Treasury, War and Commerce and the Attorney General, and three by the President. The commissioners are to receive $1,500 per month and must report on or before Nov. 15. Meanwhile work is to proceed under the Jadwin plan provided the states or local interests furnish rights-of-way and undertake to contribute their quota of the cost as well as cover all damage claims.

In an address before the Senate on Mar. 9 Senator Hawes of Missouri declared that the Jadwin plan was repudiated by 95 per cent of the witnesses appearing at the flood-control hearings. The witnesses asked, he said, for the participation of the civilian engineer, while General Jadwin has tried to push the civilian engineer farther back. They should be represented.

The Utility Investigation

The first formal hearing of the Federal Trade Commission's investigation of public utility corporations was held on Mar. 8 with officials of the National Electric Light Association on the stand, who submitted many documents. The chief counsel of the commission inquired minutely into the arrangements under which the association had purchased books for members. It was explained that by pooling the orders of members the association was able to take advantage of a 40 per cent discount. Inquiry was made as to the members of the organizations who previously had held positions as public officials.

Contract Restrictions Under Fire

Strenuous objection is being raised by the Associated General Contractors against proposed legislation that would place restrictions upon contractors engaged in public works, in the matters of preference in the employment of labor and in establishing other requirements affecting government contracts. A proposed amendment to the latter bill, requiring the use of domestic cement only, also is opposed by them. The bill dealing with preferences in the employment of labor requires the employment first of those who have been honorably discharged from the military or naval service and who are residents of the locality in which the work is to be performed. Other citizens who are bona fide residents of the state, territory or district in which the work is located are to be employed next. No aliens are to be employed if citizens of the United States are available for employment. The attitude of the A.G.C. toward the establishment of uniform requirements affecting government contracts is that such details should be matters of specifications rather than of basic law.

Personal Notes

John Weber, of the University of Pittsburgh, has been named as a member of the Pittsburgh City Planning Commission, succeeding Morris Knowles, who declined reappointment.

Theo Jensen, contractor, whose offices have been in Tracy, Minn., announces that, effective March 1, his headquarters will be in the St. Cloud State Bank Building, St. Cloud, Minn.

Porter J. Preston, superintendent of the Yuma project, Arizona-California, has been transferred to the position of superintendent of the Yakima project, Washington, in place of J. L. Lytel, who has resigned to enter private employment. Mr. Preston has been employed by the Bureau of Reclamation since 1917, the first few years being on investigation work, then as superintendent of the Uncompahgre project, Colorado, and since February, 1921, as superintendent of the Yuma project. Mr. Preston is now engaged in preparing a report on Indian irrigation and will not be able to take charge at Yakima for several weeks. W. L. Rowe has been designated acting superintendent during this interval. The vacancy caused by the transfer of Mr. Preston has been filled by the appointment of R. M. Priest as superintendent of the Yuma project. Mr. Priest has been connected with this project since 1903.

Engineering Societies

Calendar

Annual Meetings

BUILDING OFFICIALS CONFERENCE OF AMERICA, Springfield, Mass.; Annual Meeting, Detroit, Mich., April 24-27.

AMERICAN WELDING SOCIETY, NEW YORK; Annual Meeting, New York, April 25-27.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, May 7-10.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, El Paso, Tex., June 4, 5 and 6.

AMERICAN WATER WORKS ASSOCIATION, New York; Annual Convention, San Francisco, week of June 11.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION; Annual Meeting, University of North Carolina, June 25.

The American Society for Testing Materials has completed arrangements for a group meeting of 31 of its most important committees at the Mayflower, Washington, D. C., on March 21, 22 and 23. Sessions will be held mornings, afternoons and evenings.

Obituary

Austin Bradstreet Fletcher, one of the country's foremost highway engineers, died of pneumonia on March 8, at his home in Chevy Chase, Md., after an illness of a week. As state highway engineer of California from 1909 to 1919, Mr. Fletcher rendered conspicuous service in the formulation and direction of the program of modern road improvement in that state. Since July, 1924, he had served as consulting highway engineer for the United States Bureau of Public Roads.

William Titcomb Blunt, U. S. assistant engineer (retired), died in Chicago on March 3. Mr. Blunt was born at Norridgewock, Me., in 1855, and after graduating from the Massachusetts Institute of Technology in 1874, he entered the U. S. Coast Survey. He was an assistant engineer of the Massachusetts Harbor Commission in 1875 and of the Mississippi River Commission in 1879. In 1883 he became an assistant engineer in the U. S. Engineer service, on river and harbor work, and continued in this service until his retirement in 1925, except for two years with the Sanitary District of Chicago, 1890-92, and on the Panama Canal, 1908-10. In 1914 he was assigned to the Chicago office of the U. S. Engineers.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Educational Film on Danger of Explosives Available

Blasting caps, which are necessary adjuncts to the proper use of explosives, are highly dangerous as playthings for children. Reports show that when these objects are left around the scene of blasting operations, children find them and proceed to experiment with them. This results in a great number of children being blinded, maimed, and in some cases, killed. To combat this danger, which is said to result annually in 500 crippled children in the United States, the Institute of Makers of Explosives, composed of all the large manufacturers of explosives in the United States, has had prepared a one reel motion picture film designed to be entertaining and at the same time to vividly impress those who see it with the danger inherent in blasting caps. The film tells the story of a 12-year-old boy who saved the star pitcher from being injured by a blasting cap so that he could win a championship game. The film is available from the offices of the Institute at 103 Park Ave., New York City.

Concrete Road Yardage

For February the square yardage included in concrete pavement contract awards, according to the Portland Cement Association, was 7,464,342 sq.yd. The total awards for concrete roads, streets and alleys from January 1, 1928, to February 25, 1928, equalled 13,366,372 square yards.

Lime Association Meeting to Be a Round Table Discussion

For the 1928 convention of the National Lime Association, to be held at the Belmont Hotel, New York City, May 23-24, the most emphatic note is the announcement that this is to be a convention of the industry, rather than of the Association, so that there will be given opportunity for a comprehensive discussion of the critical conditions which lost over three million dollars for the industry last year with a decrease of over two hundred thousand tons in production.

To carry out this purpose there is to be no program for the convention. Members and others are submitting questions bearing directly upon conditions which prevail in various sections of the country and these questions will serve as the basis of a round table discussion.

It is announced that the chairmanship of the convention has been given to S. W. Stauffer, J. E. Baker Company, York, Pa., because of his appreciation of present conditions and his freedom from any part in the controversies which prevail. Everyone present will have an opportunity to talk as long as his remarks bear upon the real problems of the industry. Also, in order that there shall be no restraint whatever and that the discussion may be strictly free, the convention will not be reported for the publishing of proceedings. The convention committee, headed by S. W. Stauffer, is assisted by A. B. Mack, assistant to the president, Kelley Island Lime and Transport Company, Cleveland, and G. B. Arthur, general manager, National Lime Association, Washington, D. C.

Standard Forms for Concrete Floors to Be Discussed

A tentative simplified practice recommendation on form dimensions for concrete ribbed floor construction has been prepared by the Bureau of Standards. This is the direct result of a preliminary conference in the fall of 1927 with the manufacturers and distributors of these forms. Since the recommendation has been found satisfactory by a representative number of concerns, it is to be submitted to a general conference called at the meeting of the Concrete Reinforcing Steel Institute, March 21, at Biloxi, Miss.

The recommendation proposes to standardize the following:

(1) 20 and 30 in. width pans only; (2) tapers in 3 ft. lengths; total contraction of 4 in. for 20-in. pans and 6 in. for 30-in. pans; (3) both normal and tapered end pans complying with (1) and (2); (4) 10-in. and 15-in. widths for special filler forms; and (5) depths varying by multiples of 2 in. ranging from a minimum of 6 in. to a maximum of 14 in. The depth is interpreted to mean the vertical distance from the under side of the concrete slab above the center of the pan to the bottom of the concrete slab.

Business Notes

A. J. Brandt, Birmingham, Mich., has been retained to take entire charge of all factory operations of the Autocar Company's plant, Ardmore, Pa. From 1916 to 1918 Mr. Brandt was with the du Pont Company, Philadelphia, as resident engineer in charge of construction. In 1918 he had charge of the construction of the mechanical division of the Old Hickory powder plant at Nashville, Tenn. From 1919 to 1920 Mr. Brandt was at St. Louis, Mo., in charge of the erection of a new plant for the General Motors Corporation. In 1920 he also worked on plants of the company at Syracuse, N. Y., and Janesville, Wis., later being made production manager of the Samson Tractor Division of General Motors. Next he built the body plant for the Fisher Body Corporation at Janesville, Wis. His latest position has been with the Oakland Motor Car Division of General Motors at Pontiac, where he was vice-president in charge of operations during which time the new plant was constructed and put in operation.

H. C. Beckwith has returned to the Byers Machine Company, Ravenna, Ohio, as president and general manager. Mr. Beckwith was general manager of the Byers Machine Company for a number of years but retired in 1926. Now that the company has purchased the Massillon Power Shovel Company, at Massilon, Ohio, it is in the midst of an active expansion program and Mr. Beckwith's return is understood to be in line with this new policy.

William D. Updegraff was recently elected vice-president in charge of sales of the Watson-Stillman Company, New York City. For the last fifteen years Mr. Updegraff has been engaged in various engineering and sales capacities with the company.

Paradon Manufacturing Company, Arlington, N. J., announces the appointment of A. H. Webber, Amarillo, Texas, as its representative in the south and southwest sections of Texas.

New Developments

Line of Screw Jacks Incorporates Important New Features

A new line of screw jacks with improvements in design and finish is announced by Templeton, Kenly & Co., Ltd., Chicago, manufacturers of Simplex model jacks for railroads, industries, contractors and public utilities.

Instead of the usual solid frame, the new line of jacks are built with an open handhole, permitting the screw of the jack to be visible at all times. This informs the operator how high the screw may be run out, which is a practical safety feature. The carrying handle is formed as a part of the handhole, being braced and ribbed to add additional strength to the jack. The screw and head are forged from one piece of steel. The standard and cap are made of refined gray iron which is claimed to be a safe-guard against cracking or chip-

ping. The base is formed with an extra ribbing, providing stability and strength.

A novel feature is the use of Duco lacquer for color finish. This is designed to contribute to effective handling since each distinct size of jacks is lacquered in a different color. Thirty-two sizes in all will comprise the new line, embracing only the styles that are universally in demand. These sizes run from 1 by 6 in. to 3 by 24 in., providing capacities from 5 tons to 36 tons.

Metal Preservative Oil Takes All Paint Pigment

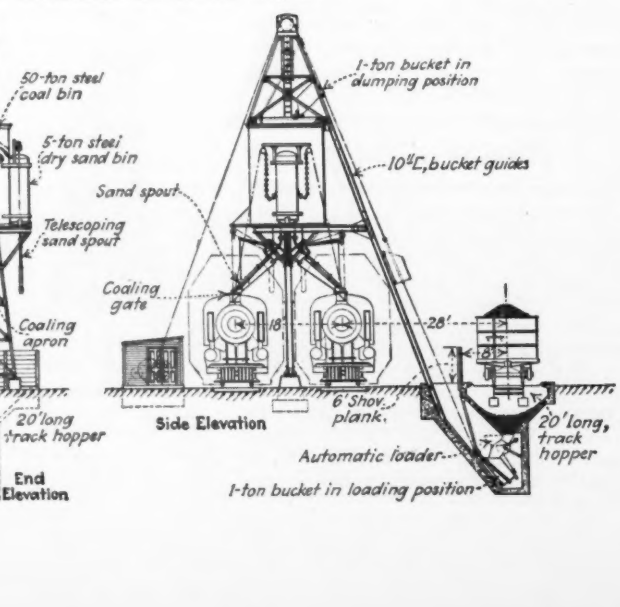
Designed to be used as a universal solvent and in fact so named, a metal preservative oil has been announced by the Detroit Universal Solvent Company, Detroit, Mich., known as F-267. Besides having an affinity for all colors and all pigments the oil is claimed to produce a non-porous, tight clinging film, highly resistant to rust and corrosion by itself. It is claimed that only 40 to 60 per cent of the pigment required with linseed oil is necessary with this new oil and that at the same time a 20 to 25 per cent greater coverage is obtained.

Medium-Sized Two-Track Coaling Plant Developed

For the handling of locomotive coal where the amount consumed is not large, care must be given to the economy of design of mechanical coaling facilities if they are to be constructed at a price which can be justified by the saving effected. To comply with this condition the two-track 50-ton coal- and sand-handling plant shown in the accompanying drawing was developed by the Roberts & Schaefer Company, Chicago. Coal is delivered from a 20-ft. track hopper to a 1-ton hoisting bucket, in which coal is hoisted at the rate of 35 tons per hour to the overhead bin. The plant is electrically operated and is automatic, so that no attention is required by the hoisting mechanism after it is once started until it is desired to stop. The bucket track, together with the vertical column supports underneath the 50-ton pocket, serves to provide a supporting A-frame structure. Therefore, no tower is required for the bucket runway and supports, nor is there an expensive supporting structure underneath the pocket. Complete accessibility to the bucket guides and other parts is provided.

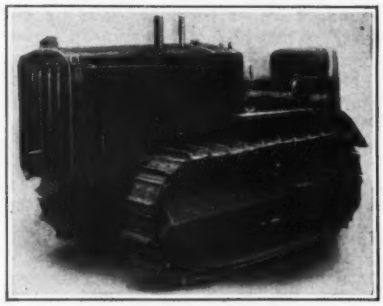
Coal is delivered to each of two tracks spaced 18 ft. apart through new type gates. A 5-ton sand bin, together with sand delivery spouts, is attached to the side of the structure.

The hoist is installed in a separate house on the opposite side from the receiving hopper, so that the load of the coal bucket is thrown directly down on the supporting structure and its foundations.



New Crawler Tractor Offered in 20-Hp. Capacity

Following two years of development and testing work, a new model crawler tractor has been announced by the Caterpillar Tractor Co., San Leandro, Calif. The new model is designated as the Caterpillar 20 from the fact that its rating is 20-hp. at the drawbar. Specifications for the new model include a



4 x 5-in. engine, selected gear type transmission, three speeds forward and one reverse, 11-in. track shoe, a 25-lb. grease pump and a net weight of 7,000 lb. The over-all length is 115½ in. with an over-all width of 61 in., and over-all height of 60½ in. The ground clearance under the transmission is 12 in. and the drawbar height above the ground is 15¾ in.

Lighting equipment includes powerful headlights, with brackets and necessary wiring. Current can be furnished either direct from a generator or by a generator and storage battery system. The new model can be adapted for belt work, developing 25 hp. when so used. A power take-off can be provided for use with various equipment, winter cab equipment is available, and an electric starter can be installed if required.

In the announcement of the tractor, the company states that an odometer, which registers distance traveled in miles, can be fitted to the new model to aid those tractor users who desire to keep accurate work or cost records.

Manufacturers and Trade Associations

Calendar

Annual Meetings

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; Annual meeting, Biloxi, Miss., March 19-21.

SOUTHERN PINE ASSOCIATION, New Orleans; Annual meeting, New York City, March 26-28.

AMERICAN WATERWORKS MFGRS. ASSOCIATION, New York City; Annual meeting, San Francisco, Calif., June 11-14.

New Publications

Garbage Sorting—CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., has recently published a new booklet entitled "Magnetic Protection," giving complete information on the company's magnetic separator pulleys to be used for removing iron from garbage, foundry sand, etc. The booklet explains in detail the construction features and includes several tables giving the cubic feet per hour capacity of all the pulley sizes and the correct width and thickness of the belts to be used.

Elevators — CHAIN-BELT COMPANY, Milwaukee, Wis., has recently published a new catalog on its elevating and conveying equipment for contractors. Besides illustrating and describing elevators and chain and belt conveyor equipment, several suggested plant layouts are included.

Road Machinery—AUSTIN-WESTERN ROAD MACHINERY COMPANY, Chicago, Ill., has published its general catalog No. 28 illustrating and describing each of its pieces of equipment for road-building work. There are included in the catalog blade graders, motor graders, elevating graders, motor rollers, street sweepers, road oilers, snow plows, road drags, dump wagons, hot-patch outfits and similar equipment.

Business Side of Construction

Facts and Events That Affect Cost and Volume

Facts on Unemployment

This being the normal season of unemployment, any survey must endeavor to find out whether unemployment is greater or less than is to be expected. Such a survey conducted by *Engineering News-Record* indicates that while there is, on the whole, a somewhat greater amount of unemployment than at this time last year, the situation cannot be called abnormal. In fact, in the building trades, business as usual is the rule. Following are bare statements of the facts in a number of representative cities, chiefly in the eastern half of the country, both north and south:

Albany—Employment situation probably better than in other eastern cities of similar size, due to continuation of building boom, and to fact that a number of small plants manufacturing electrical equipment, appliances, machinery and tools are fairly busy.

Altoona—Coal mine strike has crippled railroad traffic and eliminated car repairs, causing unemployment locally. Pennsylvania Railroad employment worst in years, with 5,000 of total of 15,000 idle. Many idle in the machine and building trade unions.

Anderson—Employment same as last year with usual 14,000 employees busy. Three industrial plants operating overtime.

Atlanta—Employment same as in early 1927, which year was better than 1926. Common labor rates down.

Baltimore—Employment conditions same as last year, with more building and other construction planned. Police census shows 15,473 idle. There are about 30,000 part time workers.

Birmingham—Unemployment considerably decreased during February from conditions in the last quarter of 1927 and from those of January.

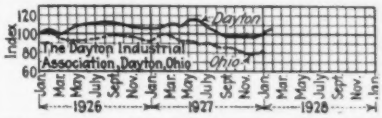
Chicago—Considerably more unemployment among building trades than last year, though no figures are submitted. There is distinctly increased competition among contractors; as an example, for the new Daily News building, on which bids closed March 12, fifteen general contractors took out plans the first day. A year ago it was difficult to get competition, even on a seven-story hotel.

Cleveland—Employment same as last year, with gradual gains in the building trades. Building permits issued in the first two months show $3,500,000 increase over same period of 1927.

Columbus—Employment about 7 per cent under last year. Common labor rate lower.

Connecticut—Skilled labor in the building trades is fully employed. Only industry reporting lower wages is the textile. Bridgeport is employing 3,000 more than at this time last year. Full employment in Hartford, New Britain, Bristol, Middletown and other central sections. Slight amount of unemployment reported in Naugatuck Valley cities.

Dayton—Industrial employment on upward trend with conditions on Feb. 1 about 8 per cent above Jan. 1 and at same level as a year ago. Chart prepared by the Dayton Industrial Association shows city in better position



INDUSTRIAL EMPLOYMENT, CITY AND STATE—JAN. 1, 1926 = 100

than state as a whole. Construction employment satisfactory, although there is a surplus of common labor, due to floaters attracted by good industrial situation.

Detroit—Employment increasing in Ford plants, total now being 95,369. Activity of automotive and construction industries is improving general situation.

Duluth—All employment less than year ago, though no figures are available. The Northwest railroads are expected to employ considerable labor this spring to carry through improvement programs. The Minnesota Steel Company plant employs 1,200 more men than a year ago.

Frankfort—In January, 1928, the number of men employed on highway construction by contractors was 1,116 and by the state on force-account reconstruction 1,941, compared with 587 and 1,759, respectively, in January, 1927.

Indianapolis—Building permits for first two months total $2,774,764, compared with $2,767,052 for 1927.

Kansas City—Unemployment in building trades 40 per cent greater than last year. Common labor rates affected.

Knoxville—Employment 30 per cent under year ago.

Lansing—Employment in eighteen leading factories totaled 14,084 in week ending March 3. Maximum employment when these plants are working at capacity is 18,000.

Lincoln—Open winter and good crops have stimulated building.

London (Ont.)—In London, Hamilton and Windsor, business has been improving and excellent year is expected. In Windsor the Ford plant is taking on 100 men a day, the Chrysler Motor Car Company is spending $250,000 on additions, and the Canadian Pacific Railway will spend $300,000 on improvements. In Hamilton $9,000,000 worth of building will start in spring. London factories are busy. Scarcity of skilled help. Union officials report no trouble in sight for May 1. Prices of materials and equipment firm with tendency in many cases to advance slightly.

Memphis—Building permits for February only $247,470 less than for February, 1927, when the Sears-Roebuck $1,369,000 plant permit was issued. Permits in first two months of each of last three years totaled as follows: (1926) $2,528,000; (1927) $3,070,000; (1928) $3,433,000. Ford plant resumes in middle of March.

Milwaukee—Unemployment greater than a year ago with 15 per cent out.

Minneapolis—Same as last year. Common labor receives 40c. an hour compared with usual rate of 45c.

Montreal—Situation good with fewer unemployed in December than in previous four years, and January unemployment under last year's. Common labor receives 25c. an hour compared with 35c. to 40c. in summer due to usual presence of transients. There are 492 building projects under way, while permits for the first two months total $2,528,265. New construction contemplates $10,000,000 in buildings, $25,000,000 for hydroelectric development, and $10,000 for public works.

Newark—Unemployment in northern New Jersey worse than a year ago, with 25 per cent of men in building trades out of work. General situation helped by employment of 1,500 additional men by Durant Motor Company.

New Orleans—Heavy unemployment, with 25 to 35 per cent of union membership out of work; of 1,000 carpenters, half are idle. The flood drove much farm labor to the city; as a winter resort there is always an influx of drifters; building depression.

New York City—Conditions much worse than a year ago. Employment in manufacturing industries under the previous low years, 1914, 1921 and 1924. In the building trades 12 per cent more mechanics idle than year ago.

Oklahoma City—Unemployment greater than year ago, when 600 men were out of work compared with 1,500 now.

Omaha—Same as year ago.

Philadelphia—Unemployment in building trades year ago was 25 per

More Contracts Let Than Last Year

In connection with employment in the building trades, it is interesting to note that the value of contracts awarded in the first two months of 1928 is 15 per cent greater than a year ago. The value of work contemplated but not yet out for estimate is practically the same as last year at this time. The figures, given below, check with specific information on construction employment received from most of the cities listed on this page.

Contracts:	1927	1928
Public	$107,588,000	$135,853,000 (+26%)
Private	249,422,000	275,421,000 (+10%)
Total	$357,010,000	$411,274,000 (+15%)
Contemplated:		
Public	$393,253,000	$431,978,000 (+10%)
Private	709,827,000	663,785,000 (— 5%)
Total	$1,103,080,000	$1,095,763,000 (—0 7%)

cent and is now 50 per cent, meaning 40,000 out. Union rates paid on large contracts, but on small jobs carpenters accept 80 cents and bricklayers $1.40, reductions of 30 and 14 per cent, respectively.

Pittsburgh—Unemployment 10 to 12 per cent greater than year ago. Union scale remains, but many mechanics working for less in non-union shops. Labor wage agreements soon expire and decrease in rates expected.

Portland (Ore.)—Employment normal, with 10 per cent of building mechanics out of work and 25 per cent out in lumber and logging trades.

Richmond—Same as year ago, with 10,000 unemployed in Richmond and 3,000 to 4,000 in Norfolk.

St. Louis—Unemployment 25 per cent greater than year ago. Many plants working part time or with skeleton forces. Due to a legal complication involving assessments and public improvements practically all street and sewer construction has been held up indefinitely, throwing 2,000 out of employment. In the building trades 60 per cent of 18,000 workers are idle or on part time compared with 25 per cent a year ago.

Sacramento—Unemployment 50 per cent greater than year ago. Construction laborers and skilled mechanics not affected.

Syracuse—Same as year ago, with 4 per cent increase in employment in last five weeks.

Texas—Building permits not as heavy as last year. Western Texas in slump due to cheap oil, but new pools around Midland, Abilene and San Angelo have increased construction activities. Fort Worth has been behind in building for several years, but now reports an increase in permits over those of last year. Conditions dull in East and Southeast.

Toledo—Industrial employment largest on record. In 51 major industrial plants 10,000 men have been added in last eight weeks, giving total of 33,813.

Trenton—Chamber of Commerce reports 4,000 idle, while unions estimate 8,000 to 10,000. About 50 out of 600 bricklayers working.

Wilmington—201 plants in vicinity employed 23,174 on Feb. 20, 1927, and 22,899 on Feb. 20, 1928. Increased employment over last year in building trades.

Business Notes

Outstanding improvement in the automotive and steel industries has directly benefited the employment situation. The Department of Commerce index of total manufacturing production showed January activity to be 11 per cent above December and only 1 per cent under a year ago. Increased production, larger shipments and orders show the lumber industry to be better than in December or January, 1927. Cement shipments in the first two months are 400,000 bbl. above last year. Unfilled orders for manufactured commodities were higher than December but lower than January, 1927. Stocks of commodities were smaller than at the end of December or January, 1927. Wholesale trade was larger during January than the preceding month and the same month last year, and retail trade is better than last year. General trade activity measured by bank debits outside New York City up to March 1, 1928, is ahead of 1927—only three weeks have shown lower totals than corresponding weeks of last year.

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended March 15, with some comparisons, total as follows:

(In Thousands of Dollars, 000 Omitted)

Week Ended	Public	Private	Total
Mar. 15, 1928..	**14,416**	**35,644**	**50,060**
Mar. 8, 1928	13,967	39,403	53,370
Mar. 17, 1927..	18,834	25,403	44,237
Jan 1, to date:			
1928.....	**181,204**	**433,017**	**614,221**
1927.....	169,047	362,932	531,979

E. N.-R. Index Numbers

Cost		Volume	
Mar. 1,1928	**204.65**	**February, 1928**	**225**
Feb. 1, 1928	204.65	January, 1928	208
Mar. 1, 1927	208.80	February, 1927	182
Average, 1927	206.24	Average, 1927	263
Average, 1926	208.03	Average, 1926	228
1913.....	100.00	1913.....	100

Steel ingot production during February showed the highest daily average and total monthly output ever recorded by the industry. Output was 4,014,774 tons and operation averaged 87.3 per cent of capacity. The automobile and construction industries are the most active buyers. Per cent capacity operations during the first week of March is 1½ per cent under the last week of February and about 5 per cent less than last year at this time. U. S. Steel Corporation unfilled orders increased 122,242 tons during February, contrary to decreases at this season in 1926 and 1927. The total of 4,398,000 tons is the highest since February, 1926.

Pig iron production was higher in February than in January; 52.1 per cent of the blast furnaces were active at the end of the month and 51.8 per cent at the end of January. This was lower than last year, when 59.5 per cent of the stacks were active.

Steel and iron export trade in January totaled 205,766 tons, the largest month since January, 1927. Imports of 5,553 tons represented a decrease of 8.9 per cent from December and 46 per cent from January, 1927.

Car loadings of revenue freight during the week of Feb. 25 were 869,590, a 2 per cent decrease from the preceding week due to the holiday on Feb. 22. Compared with the same week in 1927 and 1926 there was a decrease of 49,268 and 43,345 cars respectively. Loadings of grain and grain products, coal, and coke showed increases over the preceding week. Net railway operating income of Class I railroads totaled $57,070,898 in January—a decrease of 7 per cent from January, 1927, and lower than the same month in each year since 1924.

Business failures during the week ended March 3 were more numerous than the preceding week and the same week last year.

Value of Proposed Construction Same As That of Last Year

Contemplated construction projects (not ready for bids) valued at $1,095,763,000 were reported by *Engineering News-Record* during the first two months of 1928. This is a decrease of 0.7 per cent from last year but is larger than the total for the first two months of any preceding year.

The decrease of $191,420,000 in the Middle Western states during January and February, 1928, as compared with last year was almost entirely offset by gains in all other sections of the country. The several classes of construction which registered gains over 1927 were bridges, streets and roads, commercial buildings, federal government and public unclassified work.

Construction planning is done in greater volume in the first quarter of the year, while the second quarter is usually the most inactive, according to a study of reports covering proposed work for the last four years. Awarding of contracts is done mostly in the second or third quarter. In general a period of four to six months elapses between the first report of contemplated work and the actual start of construction.

During February, 1928, reports of proposed work were $97,000,000 less than in January. This change of 16 per cent followed the usual seasonal trend. In 1925 and 1926 the February decrease from January was 25 and 28 per cent, respectively; although 1927, moving contrary to trend, showed an increase of 17 per cent for the same period. In spite of the decrease for the whole country during the second month of the year, the Middle Atlantic, South and Far West showed increases. Excavations, streets and roads, and private unclassified projects were the only classes contemplated in larger volume than in January.

Compared with February, 1927, last month showed gains in the same sections of the country as the January comparisons showed. The classes which registered gains over February of last year were bridges, streets and roads and commercial buildings.

PROPOSED WORK BY SECTIONS
(1927 figures in parentheses)

	Total for Jan. and Feb.		Total for Jan. and Feb.
New England..	$94,409,000 (82,779,000)	Middle West....	209,953,000 (401,373,000)
Middle Atlantic...	263,809,000 (227,213,000)	West of Mississippi...	258,096,000 (238,127,000
South.....	70,727,000 (68,988,000)	Far West..	198,769,000) (84,600,000)